POWER

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The Jungle Job

By Berton Braley

I said to myself, "I am through pioneering,
I'm sick of the wilderness, lonely and rough,
I'm sick of the graders' camp, built in a clearing,
I'm weary of laborers, hairy and tough;
I'm tired of the outfit, the bed and the ration,
The steam-shovel's puffing, the shock of the blast—
I want to go back where there's civilization,
The fun and the frolic I knew in the past.

"The life that has savor and vim in,
The sights and the noises of towns,
The laughter and lure of the women,
The glitter of jewels and gowns;
I'm done with this business forever,
I'm off to see 'cities and men',
And once I have landed, I'll never
Come back to the 'Jungle' again."

So I made for the city of wonder and glamor
The city whose glory had shone in my dreams,
I plunged with delight in its hurry and clamor,
Its welter of hopes and ambitions and schemes;
I reveled again in the food and the raiment,
The music and lights and the movement and mirth,
And I said to myself, "There is no form of payment
Can tempt me again to the outposts of earth."

But in spite of the pleasuring places,
In spite of the vast city's thrill,
The spell of the unconquered spaces
Came following after me still;
At night it would suddenly wake me
By day it would whisper and then
I knew it was trying to make me
Come back to the Jungle again.

I had thought that the softness of cities would tame me
I fought with the thrall of a life I reviled,
But the lure of the game I had played overcame me
—The struggle with Nature far out in the wild.
The flesh-pots were sweet, but they never could hold me
I packed up my kit and I made for the trail,
And now I believe what the Old Timers told me,
"The spell of the wilderness never can fail."

I'm back to the "furthermost farness,"
I'm way, way "ahead of the steel,"
I'm wearing my engineer's harness,
The gravel is under my heel;
The dreams of the city still bind me,
The call of it comes to my ken,
But somehow I left it behind me,
I'm back to the "Jungle" again.

Coon Rapids Development

SYNOPSIS—Five vertical single-runner waterwheels to develop 10,500 hp. on an average head of 17.5 ft. Output of plant to serve Minneapolis.

As shown in the accompanying summary of generating and substations, the Northern States Power Co. controls and operates large interests developing power by water and steam. According to the statistics, there is now in operation 76,677 electrical horsepower in generators, driven by 31,500 hp. of steam turbines, 12,600 hp. of engines and 34,925 hp. of waterwheels. By far the largest part is developed within a radius of 75 miles from Minneapolis.

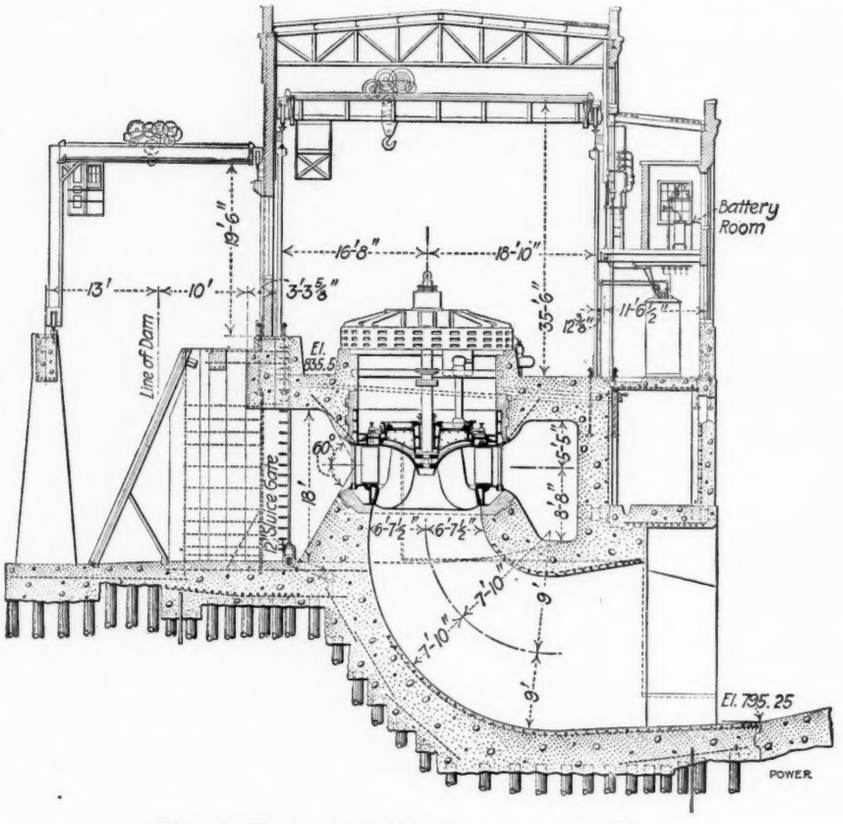


FIG. 1. TRANSVERSE SECTION THROUGH PLANT

The properties here are divided into four main divisions, designated as Stillwater, Minneapolis, St. Paul and Mankato-Faribault. The several municipalities in each of these main divisions are connected by high-tension transmission lines with the main generating stations of the division. The city of Minneapolis and the towns in this division are connected by high-tension transmission lines to the hydro-electric stations at Taylors Falls and St. Anthony Falls, known as the Main Street Station, and to the large reserve steam station at Riverside, Minneapolis. The entire division is also interconnected through a high-tension trunk line with the steam power house of the St. Paul division. Similar interconnecting systems exist between the hydro-electric and steam stations of the Stillwater and Mankato-Faribault divisions. Within the year it is intended to interconnect all of these divisions, so that a transfer from one hydro-electric station to another will be possible and permit a number of the smaller steam stations to be shut down.

The latest addition to the Minneapolis division, not included in the foregoing summary, is the development at Coon Rapids, which is on the Mississippi River, about six miles north of the city limits and 11 miles from the Main Street station. H. M. Byllesby & Co., engineers and constructors, have already finished the dam and the power house is under way. By the first of September, it should be in full operation.

The plant is to have an initial capacity of 10,500 hp., made up of five 2100-hp. units, with space for two more, so that eventually 14,700 hp. will be developed. A three-phase transmission line will connect the plant with Minneapolis, and it is intended to build a second line to Anoka. The location of the site relative to the other plants, with the exception of those of the Mankato-Faribault division, is shown in Fig. 4.

The feature of the plant is the low head, which, from previous data taken at St. Anthony Falls, will vary from 13 to 20 ft., and average 17.5 ft. To utilize this head to advantage, vertical single-runner waterwheels were designed by the Allis-Chalmers Co. to turn at 62 r.p.m. The wheels will be directly connected to the General Electric generators rated at 1625 kv.a. and designed to deliver to the station bus three-phase, 60-cycle current at 2300 volts. By delta-connected transformers the tension will be increased to 13,200 volts to lessen the cost of transmission. There are seven transformers having a total capacity of 13,000 hp. and space is provided for three more. The generators are of the suspended type and, due to the low speed, are of large size. Two 300-kw., induction-motor-driven exciter sets will furnish excitation, one to act as a spare. A waterwheel unit was not considered necessary, due to the connection with the other stations. A remote-controlled, electrically operated

FIG. 2. PART OF DAM, SHOWING CONCRETE CREST AND TAINTER GATES

switchboard will be installed and a small storage battery for operating the oil switches and emergency lights. The layout of the plant is shown in the plan view, Fig. 3, and in the sectional elevation, Fig. 1. The building itself, 202x49 ft., will be of concrete, steel and brick.

crest. They will pass all water not used through the wheels and will be so operated as to maintain a uniform-head water level. The spillway has been designed to pass 80,000 sec.-ft., although 60,000 sec.-ft. is the maximum stream flow recorded. The draft tubes, which are 12 ft. 6 in. diameter at the wheel and widen out

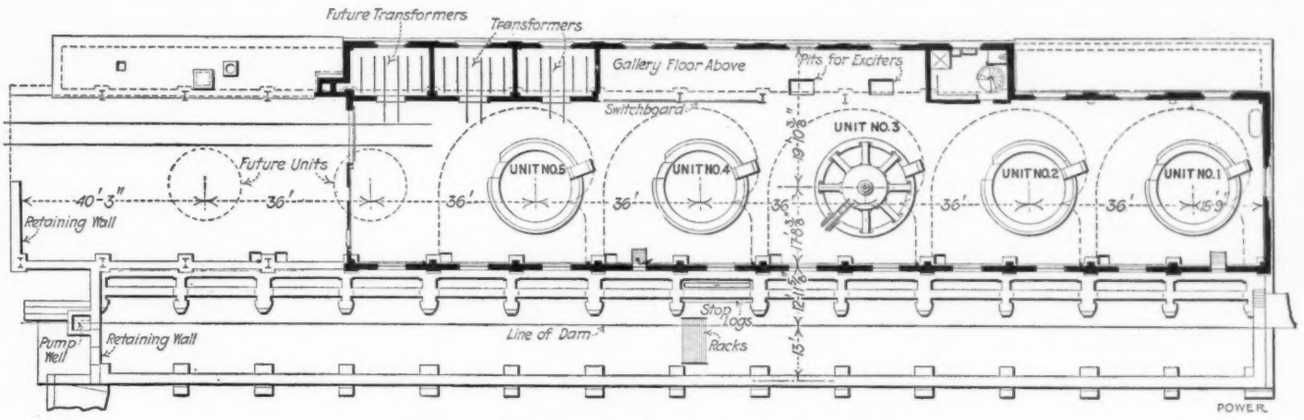


FIG. 3. GENERAL PLAN OF SUPERSTRUCTURE

As the dam passes over a small island in the river at this point, the river has two channels, one wider and more shallow than the other. Across the former channel a spillway-concrete dam of the gravity type, 1000 ft. long, was built. The power house, measuring 500 ft. with the retaining section of the dam, was built across the narrower channel; a 560-ft. earth embankment makes the total length of the dam over 2000 ft.

For its full length the gravity spillway section of the dam is surmounted by 28 Tainter gates, each being 33 ft. long and weighing six tons. These gates, shown in Fig. 2, raise the pond level 7½ ft. over the concrete as they proceed toward the tail race, have been designed for a capacity of 1320 cu.ft. per sec. at the average head of 17.5 ft.

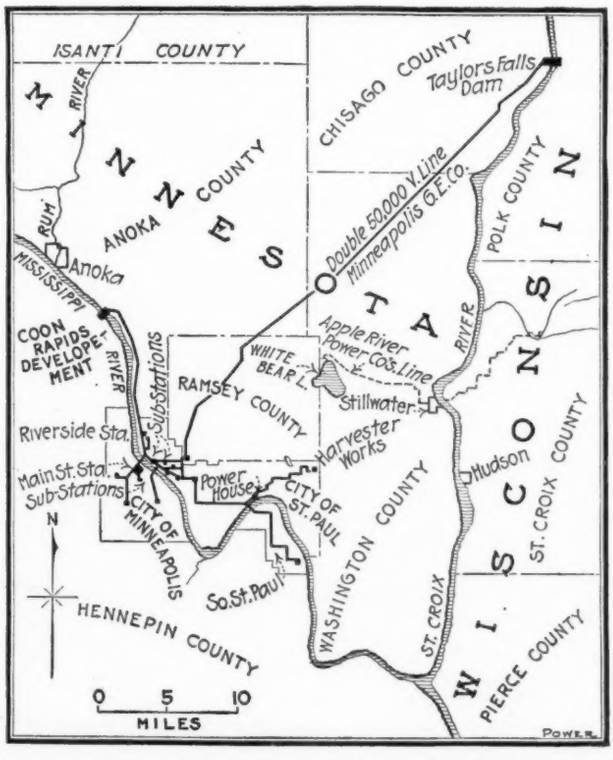


FIG. 4. TRANSMISSION LINES, NEAR MINNEAPOLIS, OF NORTHERN STATES POWER CO.

SUMMARY OF ELECTRICAL POWER PLANT EQUIPMENT OF NORTHERN STATES POWER CO.

Location	Boiler Hp.	Engine Hp.	Water Wheels Hp.	Steam Turbine Hp.	Rating of Generators E.Hp.	Transformer Hp.	Motor-Gen. Hp.
Cannon Falls, Minn.	.....	.....	1,800	.....	1,470	3,600	.....
Cuba City, Wis.	.....	.....	.....	.....	.....	1,340	.....
Darlington, Wis.	.....	.....	.....	.....	.....	200	.....
Dilworth, Minn.	.....	.....	.....	.....	.....	334	.....
Dundas, Minn.	.....	.....	.....	.....	.....	27	.....
East Grand Forks, Minn	.....	.....	.....	.....	.....	40	.....
Faribault, Minn.	600	775	125	.....	900	1,340	.....
Fargo, N. D.	2,248	2,080	.....	400	2,480	.....	365
Galena, Ill.	2,430	3,670	.....	2,680	6,350	5,350	134
Grand Forks, N. D.	2,668	2,280	.....	600	3,030	795	134
Hazel Green, Wis.	.....	.....	.....	.....	.....	2,680	.....
Janesville, Minn.	.....	.....	.....	.....	.....	134	.....
Lindstrom, Minn.	.....	.....	.....	.....	.....	134	.....
Kasota, Minn.	.....	.....	.....	.....	.....	535	.....
Lake Crystal, Minn.	.....	.....	.....	.....	.....	100	.....
Mankato, Minn.	600	1,910	.....	.....	1,340	2,140	.....
Minot, N. D.	1,040	700	.....	.....	670	.....	.....
Minneapolis:							
Taylors Falls	.....	.....	25,200	.....	20,000	21,450	134
Riverside	6,000	.....	.....	16,100	16,100	20,000	.....
Main	.....	.....	3,400	.....	2,610	8,000	800
Substation A	.....	.....	.....	.....	.....	20,520	.....
5th St.	450	535	.....	.....	5,875	5,340	.....
Garfield	.....	.....	.....	.....	.....	4,000	.....
6th St.	.....	.....	.....	.....	.....	.....	2,980
Mis. Substations	.....	.....	.....	.....	.....	12,260	.....
Morristown, Minn.	.....	.....	.....	.....	.....	100	.....
Northfield, Minn.	100	150	.....	.....	154	535	.....
Platteville, Wis.	610	160	.....	.....	160	1,340	.....
Randolph, Minn.	.....	.....	.....	.....	.....	240	.....
Rapidan, Minn.	.....	.....	2,200	.....	2,010	3,350	.....
Red Lake Falls, Minn.	150	150	400	.....	240	.....	.....
Riverdale, Wis.	.....	.....	1,000	.....	667	800	.....
St. Paul, Minn.	5,600	.....	.....	10,720	10,720	9,400	.....
Manhattan Sub.	.....	.....	.....	.....	.....	1,200	1,070
Merriam Pk.	.....	.....	.....	.....	.....	800	.....
Shakopee, Minn.	.....	.....	.....	.....	.....	400	.....
Shullsburg, Wis.	.....	.....	.....	.....	.....	400	.....
Somerset, Wis.	.....	.....	800	.....	667	1,000	.....
S. St. Paul, Minn.	265	190	.....	.....	234	800	.....
Stillwater, Minn.	640	.....	.....	1,000	1,000	1,600	.....
Waseca, Minn.	.....	.....	.....	.....	.....	400	.....
Waterville, Minn.	.....	.....	.....	.....	.....	700	.....
White Bear, Minn.	.....	.....	.....	.....	.....	400	.....
Zumbrota, Minn.	.....	.....	.....	.....	.....	700	.....
Total	23,401	12,600	34,925	31,500	76,677	134,484	6,217
The total does not include equipment for the Coon Rapids generating station which will be in operation late in 1914, and is as follows:							
Coon Rapids	.....	.....	10,500	.....	10,500	13,000	900

Alabama Coal Production in 1913—The production of coal in Alabama in 1913 was 17,678,522 short tons, valued at the mines at $23,083,724, according to figures compiled by E. W. Parker, of the United States Geological Survey, in coöperation with the Alabama Geological Survey. The increase compared with 1912 was 1,577,922 short tons in quantity and $2,254,472 in value.

Gatun Hydro-Electric Plant

SYNOPSIS—Description of hydro-electric plant utilizing the surplus water of Gatun Lake, which forms part of the Panama Canal. This plant has a maximum capacity of 7500 kw. and furnishes electricity to the entire Canal Zone.

Heretofore, interest has centered chiefly on the construction of the Panama Canal. Now that this work has been practically completed and regular service is about to be instituted, attention turns to the operating features, in which electricity plays a most important part. The enormous water storage afforded by the artificial Gatun Lake, fed by the Chagres River, will not only carry vessels the greater part of the distance across the Isthmus at 85 ft. above sea level, and provide water for raising and lowering them through the locks, but it will also supply the hydro-electric station at the Gatun dam. This will furnish electricity for operating the locks, towing the ships through them, lighting the entire Canal Zone, operating the coal-handling plants, drydocks and machine shops at Cristobal and Balboa, and will eventually run the Panama R.R.

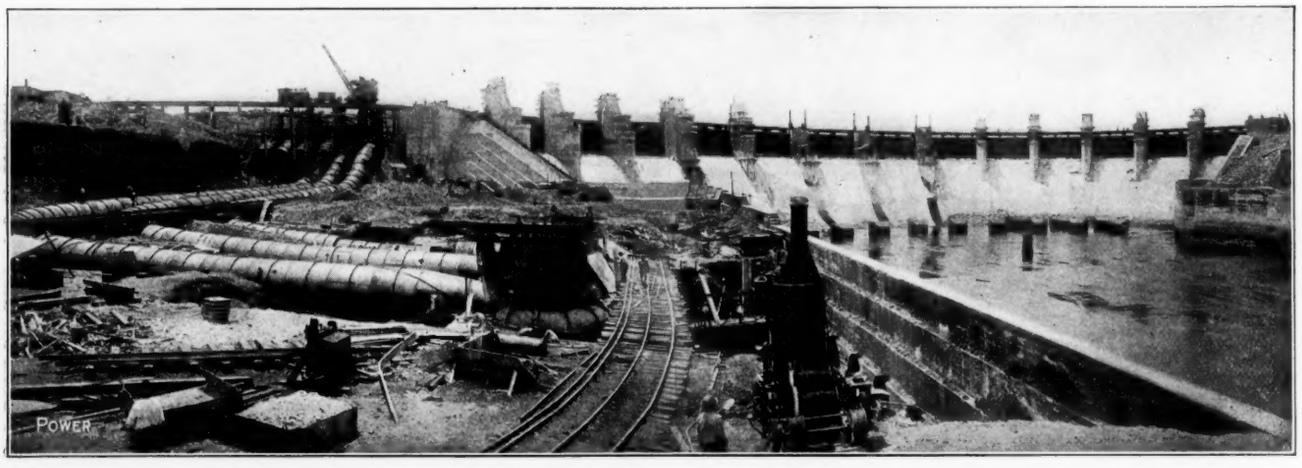


FIG. 1. PANORAMIC VIEW OF PLANT UNDER CONSTRUCTION, SHOWING PIPE LINES AND TURBINES IN PLACE

To insure continuity of service, the steam station at Miraflores, erected a few years ago for construction work, will serve as a standby plant.

The electricity is generated at 2200 volts and is sent at 44,000 volts over a double transmission line across the Isthmus to Balboa and Cristobal. There are four 44,000-2200-volt substations, one each, stepping down at Balboa and Cristobal and up or down at Gatun and Miraflores, depending on which of the two plants is supplying power. The voltage is further stepped down by thirty-six 2200-240-volt transformer stations at the locks and others at the two cities mentioned.

The crest of the Gatun dam has a length of 8000 ft. and an extreme width of 2100 ft., the height above the normal lake level being 30 ft. Since the gross head available varies from 91 ft. during flood periods to 79 ft. during the dry season, the plant has been designed to develop full output at an effective head of 75 ft.

Water is taken from the lake through passages 12 ft. wide, fitted with iron racks to prevent trash from entering the pipe lines. It is then admitted to the pipe lines through three 10.5-ft. head gates. Each gate is driven by a 15-hp. motor automatically controlled by a limit switch on one of the gate stems and also by a float; the operation is essentially as follows:

Assuming the gate to be closed, the switch is thrown at the power house and the motor starts to open the gate. When the latter has opened sufficiently to fill the pipe line, in about 5 min., the limit switch opens the circuit and stops the motor. The gate remains in this position until the pipe line is full and the water rises in the 36-in. air vent just below the gate, when it actuates a float switch and again closes the motor circuit, thereby causing the gate to be opened fully. The gate is closed by reversing the main switch at the power house. If necessary, the gates may be hand-operated.

Pipe lines 10.5 ft. in diameter and 420 ft. long lead from the gates to the turbines to which they are attached by 90-deg. bends. Each of the pipe lines is arranged for attaching a pitot tube, while its unit is in service.

POWER HOUSE

The building is of concrete, with a Spanish tile roof, and measures 61x137 ft., with an extreme height of 74 ft. It is designed on the unit principle to admit of future extension and consists of a single room open to the roof. The turbine pit is 6 ft. below the main floor and there are two galleries devoted to the switchboards, oil-switch compartments, reactance coils and other electrical equipment, as well as the office and a small machine shop for repair work.

GENERATING UNITS

There are three main generating units, each consisting of a 2000-kw. vertical generator driven by a 50-in. single-runner Francis turbine, rated at 3600 hp. when operating under an effective head of 75 ft. and at a speed of 250 r.p.m. The center line of the runners is 20 ft. above

tail water, and the discharge is through steel-lined concrete draft tubes 71 in. in diameter at the turbine and increasing to an elliptical section of 9x17 ft. at the outlets. A roller thrust bearing mounted on top of the generator carries the weight of the revolving parts of both the turbine and generator. The turbine is so designed, however, that, when running at full capacity, the runner exerts an upward thrust of 10 tons, thereby relieving the thrust bearing of that amount of load.

Oil for the thrust bearing is supplied by a small pump geared to the main turbine shaft, and a tank is provided below the pump to receive the overflow from the bearing.

Each turbine is controlled by a Pelton oil-pressure governor, mounted on the distance rings and driven by bevel gears from the main shaft. Tachometers are directly connected to the governor heads. The governors are fitted with small electric motors for varying the speed of the main units for synchronizing purposes, and a device is provided on each governor for varying the permanent drop in speed from no load to full load.

The wicket gates for controlling the supply of water to the runners are steel castings with hand-finished surfaces. Each has its pivot stem extended upward through a packing gland, and is fitted with an operating lever. All the gate levers are connected to the gate ring by means of bronze links, and the ring is connected to the governor rockshaft. The water passages on each side of the gates are provided with renewable rolled-steel wearing plates.

The generators are of the revolving-field type, and each is provided with a direct-connected exciter. Current is generated at 2200 volts, three-phase and 25 cycles, and each machine is guaranteed to deliver 2000 kw. at 80 per cent. power factor and a temperature rise of 40 deg. C. above room temperature, and an overload rating of 2500 kw. for two hours with a temperature rise of 55 deg. C. On the official tests they showed an efficiency of 95.1 per

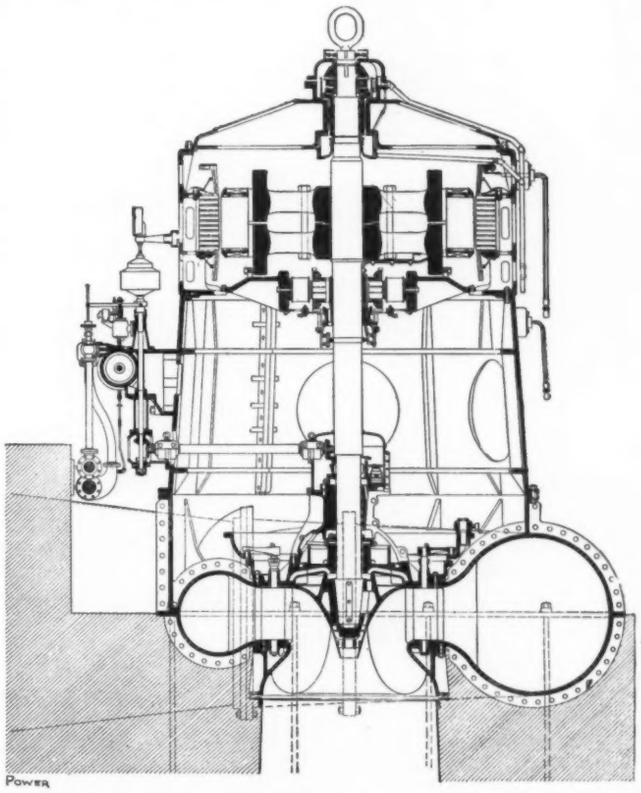
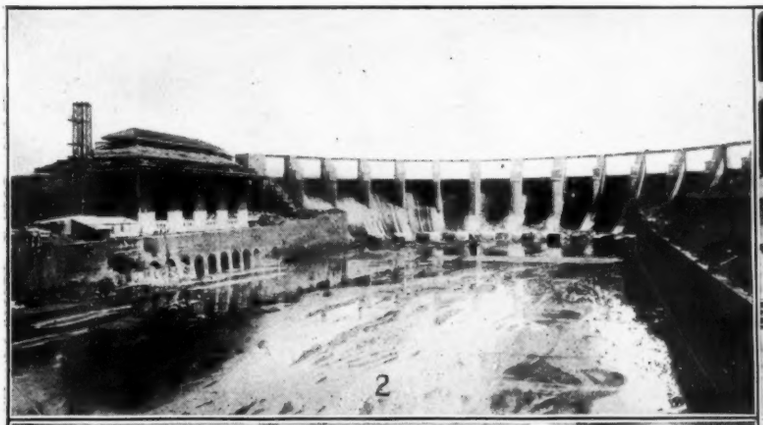
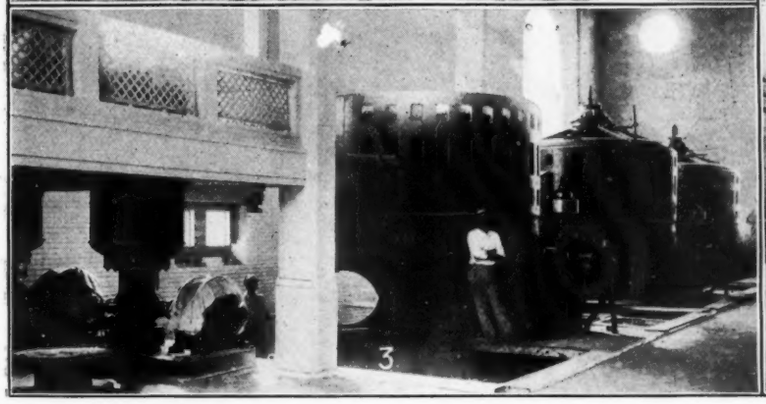


FIG. 5. SECTION THROUGH ONE OF THE MAIN UNITS





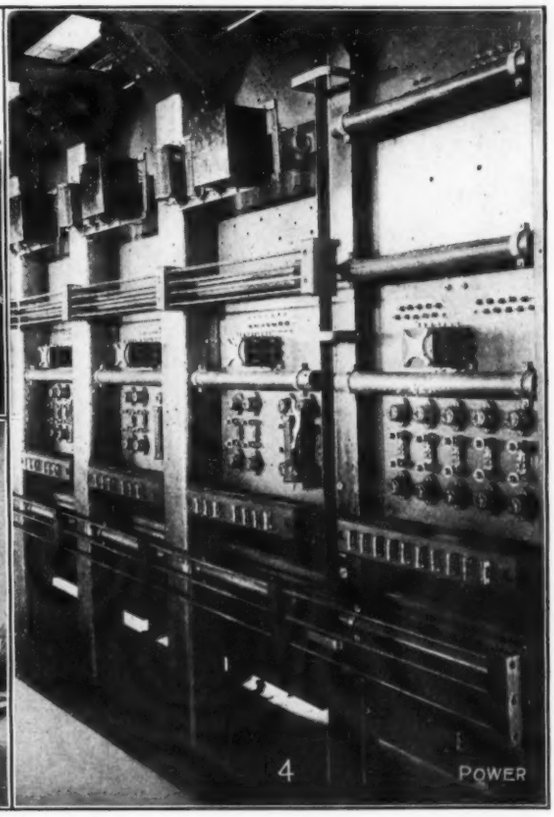


FIG. 2. SPILLWAY DAM, SHOWING CREST GATES, OGEE DAM AND BAFFLE PIERS; HYDRO-ELECTRIC STATION ON LEFT. FIG. 3. TURBINE ROOM. FIG. 4. REAR OF SWITCHBOARD

cent. at 2000 kw., 94.3 per cent. at 1500 kw. and 92.5 per cent. at 1000 kw., the power factor in each case being 80 per cent.

Besides the direct-connected exciters, there are two motor-driven exciters, each consisting of a 100-kw., 125-volt generator and a 150-hp., 2200-volt, 25-cycle, squirrel-cage induction motor. The exciters may also be used for charging the control battery.

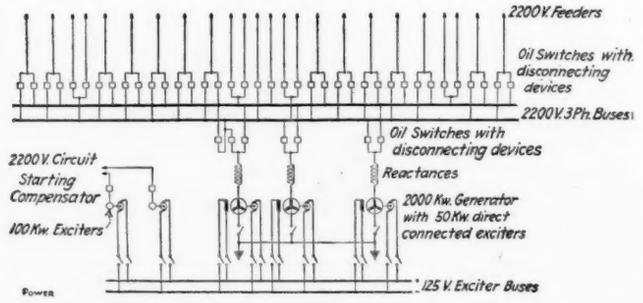


FIG. 6. DIAGRAM OF CIRCUITS

Current-limiting reactances are provided to give 5 per cent. reactive drop at 2500 kv.-a. Besides serving to reduce the shock on the generator winding, in case of a short-circuit, these reactances will render the operation of synchronizing easier and safer.

A double busbar system of connection is employed in both the generating stations and the substations.

SWITCHBOARDS

The main switchboard, in the upper gallery, is of the benchboard type, with a vertical rear board for the relays,

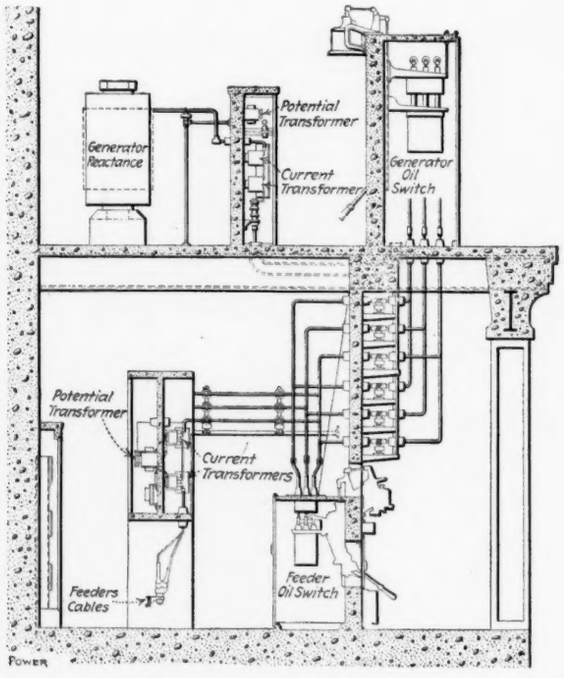


FIG. 7. GALLERIES WITH BUSBAR COMPARTMENTS AND SWITCHING EQUIPMENT

meters, etc. The space between the front and the rear board is inclosed by a grille. On top of the switchboard is a second story for the electrically controlled generator and exciter rheostats. There are five panels, the first controlling the exciters, the next three the generators and the fifth the 24 outgoing feeder circuits. That the operator may always have a clear idea of what he is doing and thus avoid mistakes in switching, the system of connections is represented by dummy busbars of polished copper on top of the bench. The voltage regulator, synchroscope and clock are carried on a separate pedestal.

Although the exciters are controlled from the benchboard, the exciter and field switches are mounted on a separate board, so as to make the exciter connections as short as possible.

BUSBAR AND SWITCH COMPARTMENTS

All the busbar and switch compartments are of concrete. From the generator oil switches on the second

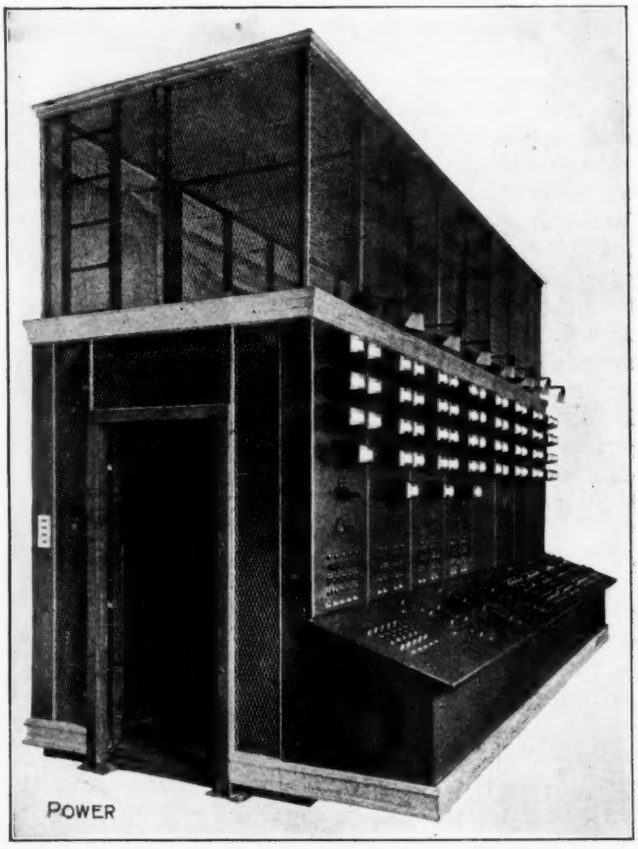


FIG. 8. INSTRUMENT AND CONTROL BOARD

gallery, connections run through the floor to the busbar compartments below, on which level are also the feeder oil switches and the compartment for the instrument transformers and cable bells; this is shown in Fig. 7.

The 2200-volt oil switches are all solenoid operated and are provided with mechanism for readily disconnecting them for cleaning or repairs. For the hand-operated switches, a pipe framework supports vertical metal guides, which carry the switch-operating mechanism and slate base. On the guides is mounted a lever and toggle device by which the switch and base can be raised and lowered. When the switch is lowered it is completely isolated from the circuit, and when raised, it always goes to a fixed height, where it is latched. An interlock prevents it from being raised or lowered unless its contacts are open.

The complete hydraulic equipment was designed and built by the Pelton Waterwheel Co., and the electrical equipment by the General Electric Co.

Another Boiler Explosion Due to Breathing

On Monday, June 8, at 6:43 a.m., a water-tube boiler exploded in the power plant of the Meridian, Miss., Light & Power Co., killing one, injuring two and inflicting some $20,000 worth of property damage.

FIG. 1. VIEW OF THE BOILER, SHOWING THE TUBES AND HEADERS INTACT

The boiler was a 250-hp. Heine, built 11 years ago. It contained 138 three and one-half-inch tubes 18 ft. long and the drum was 48 in. in diameter and 22 ft. long; both heads and shell were of ½-in. sheet. The pressure at the time of the explosion was 155 lb.

The explosion was caused by the failure of the rear drum-head, which broke out in a circular rupture along the heel of the flange as seen in Figs. 1 and 2. These two illustrations also show that the tubes were not injured. The head was bumped to a radius of 60 in. as was the practice of the Heine company for all diameters at the time the boiler was built. A tendency to crack where the radius changes abruptly having been observed, the practice was modified in 1905 by adding one-eighth of an inch to the thickness of the heads, and in 1908 the radius to which heads are bumped was changed from 60 in. for all diameters to the diameter of the shell. The appearance of the fracture indicates clearly that the rupture started on the inner surface of the head and extended outward through the sheet until separation occurred. The line of fracture followed almost a true circle around the bend of the flange.

It is a clear case of the effect of the fatiguing action of countless movements of the head about the line at which an abrupt change of shape occurs in flanging, of which there have been a number of recent examples. When the explosion happened the boiler turned a complete somersault and went entirely through the brick wall, completely wrecking the boiler house, as shown in the illustrations, and so badly damaging the power house as to require reconstructing that end of the building

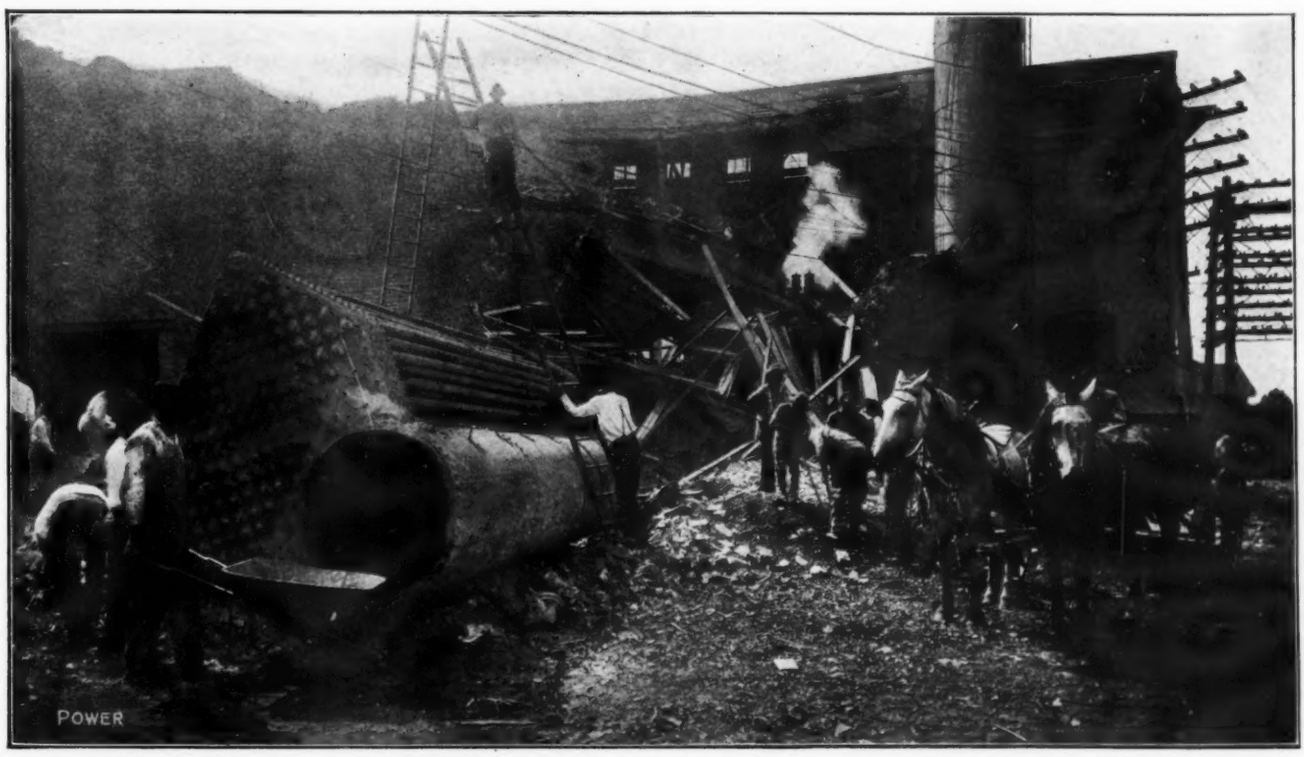


FIG. 2. RESULT OF A BOILER EXPLOSION AT THE MERIDIAN LIGHT & POWER COMPANY'S PLANT, MERIDIAN, MISS.

Speed Variation of Shunt Motors

By H. M. Phillips

SYNOPSIS—The variations in speed of a shunt motor with the temperature of the fields and with the load, also the effect of speed variation on the commercial applications.

It is generally assumed that a shunt motor runs at approximately constant speed under all loads within its capacity. Few purchasers seek further information, few salesmen can give anything much more definite without reference to the factory and, in the writer's opinion, but few factories can give complete and definite information without first conducting a series of tests; and yet the subject is of considerable importance.

For almost any class of work there is one best speed, a fact upon which the efficiency and production experts lay great stress. Falling below that speed means a corresponding loss of output, and the least that an excess of speed can do is to cause a loss of power proportional to the increase; in many cases, the power consumed rises much more rapidly than the speed, to say nothing of the evil effects likely to be produced on the tools or their product.

Effect of Temperature on Speed

One point to which little attention is ordinarily given is the increase in speed due to temperature. It generally requires from five to eight hours of operation under full load to bring the fields to a constant temperature, during which time the speed is constantly rising. In some motors the total rise will not exceed 3 per cent., while in others it may go as high as 45 per cent. The variation in speed between starting throughly chilled on a winter morning and the end of a day's run on a hot summer day will be materially greater. The increase is by no means constant during the time required for the temperature to reach its highest value. It is almost invariably much greater during the first hour of operation than for subsequent periods, although exceptions are occasionally found.

It is obvious that the increase of field temperature will be rapid at the start, but slow during the latter part of this period, and the resistance of the field windings increases practically uniformly with the temperature, roughly, about 0.4 per cent. for each degree Centigrade. The increase in speed, although due to diminution in field current caused by this rise in resistance, is by no means proportional to the diminution. One motor may be so designed that the iron in its fields is nearly saturated when operating under normal conditions, in which case there will be little speed variation with temperature as the weaker current is able to give about all the magnetism that the fields are capable of carrying. A different design may work with the fields far below the point of saturation, in which case a change in field current will produce a nearly proportional change in magnetism and an inverse change of speed. A motor may have its fields fairly well saturated when cold but be considerably below saturation when hot; then a given change in temperature will have a greater effect on the speed after the fields are well heated than when they are cold.

Although saturated fields are advantageous in their effect on the change of speed with temperature, they work in the opposite direction when variations in line voltage are considered. It is generally assumed that the line voltage is constant, but that plant is fortunate which is not subject to variations of 5 per cent., while 10 per cent. is not uncommon. If the iron were absolutely saturated at the lowest voltage at which the motor would be called upon to operate, the speed would be directly proportional to the voltage. If the fields were so weak that the magnetism varied directly in proportion to the field current, there would be practically no change of speed with ordinary changes of voltages. Neither of these conditions can exist in a commercial motor, but one or the other may be approached to an extent that will make a considerable difference in the speed variation of two different motors.

Variation of Load

In the majority of cases the variation of speed with changing load is of less importance than the cases already noted; but here also will be found a marked difference in the characteristics of commercial motors. A few instances will be found where a simple shunt motor runs at a slightly higher speed under full load than on no load; the same pecularity is more frequently found with interpole motors. For the other extreme, there are motors that show an increase of 15 per cent. or more between full load and no load. An increase of speed with the load is seldom if ever desirable, as it is likely to lead to an unstable condition.

Aside from the comparatively few cases where it is demanded by the nature of the work, close speed regulation is apt to prove an unnecessary hardship both on the motor and on the driven machinery. The response of the electric current to a change in load is practically instantaneous, more rapid than the best mechanical governor for steam or other power, and the result is that there can be no momentary slackening of speed to relieve heavy strains, such as may be introduced by the sudden acceleration of reciprocating parts, slightly defective gears, hard spots in the material being worked or carelessness by the operator. One is not likely to appreciate how violent these fluctuations may be until a sensitive ammeter is placed in the circuit of a motor giving close regulation; in fact, sometimes the ammeter may be too slow or "dead beat" to show the full value, and one may be surprised to find the circuit-breaker being thrown on what are apparently low currents, or may blame the motor for sparking when the fault is at least partially that of the load it is attempting to carry.

Going to the other extreme, we will find shunt motors that show a speed variation of 15 or 20 per cent. between full load and no load; though such high figures are generally found only on very small motors or those designed for variable speed. For shunt motors, a variation of approximately 5 per cent. appears to be about the average for reliable makes, but the extremes are by no means confined to low-grade machines.

It is generally assumed that for shunt- and compound-wound motors the reduction in speed is directly proportional to the load; that if there is a drop of 8 per cent. from no load to full load there will be 2 per cent. drop at one-quarter load. Performance curves are frequently plotted by taking the speeds at full load and no load and

drawing a straight line through the two points. It is safe to say that this straight-line characteristic is never obtained in a commercial motor, although where the total variation is small, no material error is likely to be introduced by its use. In the majority of motors the drop in speed is most marked between no load and quarter load; frequently half of the full-load drop will be found between these points, and cases have been observed where the drop at quarter load is greater than at full load, the latter condition, however, is rare.

Another common characteristic is an abrupt falling off in speed when the motor is overloaded; sometimes this may commence before the full-load point. In the majority of cases there is a considerable drop in speed from no load to quarter load, a comparatively uniform but less rapid decrease between quarter and full load with a total of about 6 per cent. at full load, and a more rapid decrease beginning at some point between full load and 25 per cent. overload. The variations, however, take a wide variety of forms; some cases have been noted where there is a fall in speed from no load to quarter load, a rise between quarter and half load and a fall at points beyond half load.

It is difficult for the purchaser to obtain information prior to an actual test on the individual motor, as to the character and amount of speed variation with load. A manufacturer may be willing to guarantee that the variation will not exceed a given amount, 10 per cent. being a common figure, but he is usually silent as to the performance within that figure, and a low variation may be a serious defect; or nearly all of the variation may be between no load and quarter load, which amounts to much the same thing. Having obtained one motor of a given make that is entirely satisfactory is not necessarily an indication that a second one will be so; if either the speed or the horsepower be different, there may be quite a radical change in the speed variation. There are differences in the electrical properties of iron that will cause one motor to differ from another; slight variations in the setting of the brushes, which may be accidental, or wrongly employed to bring the motor to its proper speed, will also affect the speed variation. Finally, after a period of service, the condition of the commutator and brushes may alter the original characteristics.

Commercial Applications

The use of compound-wound motors is, for the most part, confined to rolls, shears, shapers, planers, presses and machines equipped with flywheels, where their use is almost essential for satisfactory service. Their speed variation from full load to no load is usually in the vicinity of 5 per cent., but almost any desired amount can be obtained if specified. Where a variation of over 10 per cent. is not objectionable, the use of compound motors is apt to give better results and require less repairs than shunt-wound motors, and the slight difference in cost should prove a good investment.

From the foregoing it will be seen that the purchaser who has well defined ideas as to what he wants in regard to the speed characteristics of his motor will find it difficult, if not impossible, to find a manufacturer to comply with them. The usual guarantee that a motor will give "satisfactory" service will hardly cover the case unless one can stipulate just what is to constitute satisfactory service. If a motor operates its machine successfully but gives slightly less output for the machine or consumes a little more power than the best possible motor, it would not be ordinarily considered unsatisfactory, although either of those conditions may mean the loss of many dollars in a year. A motor whose commutator must be turned once a year, or even once in six months, may not be defined as unsatisfactory, but one that will go for two years or more without turning is certainly much better. Although the performance curves given in the bulletins of reliable manufacturers are generally those of one or several motors that are supposed to be fair representatives of the entire line, motors of a different rating in either speed or horsepower may depart materially from these results.

A variable-speed motor giving a ratio of two to one or over, and provided with the necessary controlling apparatus, is much more costly than a constant-speed motor; but almost any constant-speed motor can be fitted with a field rheostat at slight expense so as to enable one to raise its speed as much as 10 per cent. above its normal rating with no injurious effect on the motor. Such an arrangement, although seldom used, is desirable sometimes; the rheostat being divided into quite a large number of steps will enable one to get the exact speed within the maximum and minimum limits desired to compensate for the rise due to heating, for variable voltage, for pulleys that do not give exactly the desired ratio, and to experiment on the possibilities of obtaining increased output through a slight increase of speed. If so desired, the rheostat may be put under lock and key, so that the speed can be adjusted only by the foreman or some other authorized person, the motor being started and stopped by the operator in the usual manner.

Draft over the Fire

To burn coal in a boiler furnace requires air, and if efficiency is sought this air must be supplied in the proportion suitable to the coal on the grate. The quantity of air carried to the fuel depends on the strength of the draft over the fire for a given thickness of fuel bed. It is important then to have the draft right at this point. The draft at the stack, when taken in conjunction with the reading over the fire, indicates the drop through the setting and breeching, but if only one reading is to be taken, it should be the latter.

When referring to the draft of a boiler it has been common to give a reading taken at the base of the stack. This is misleading as it is lower than the draft at a point in the stack just above the breeching or in the breeching itself on the stack side of the damper, and is no gage of the draft intensity over the fire. It is not surprising, therefore, that resistances proportionally large have been interposed between the stack and the furnace. This results in reducing the draft over the fire too low for good combustion.

The common faults have been breechings too small to carry the gases without undue resistance, breechings with too many turns, dampers located so that they interfere when fully open with the flow of gases, restricted areas in boilers that were baffled and in some cases the combustion chamber has been clogged with checkerwork or other needless resistances. Even when properly proportioned and with its base straight from one end to the other, a breeching interposes considerable resistance. It

is usual to allow one-tenth of an inch of water for every hundred feet of run and two-tenths is better for the usual conditions. Every 90-deg. bend adds five-hundredths to this amount and an equal resistance is set up when the gases of one boiler pass the uptake of another. The resistances offered by the damper and the other factors mentioned will depend on the installation, but in a plant of ordinary size, anywhere from 3/8 to 3/4 in. of draft may be wasted by needless obstruction to the flow of gases.

With so much resistance cutting down the draft, the average stack has not been high enough to produce the best results, and particularly when the fuel is highly volatile, as then a strong draft over the fire is needed to pull in enough air for good combustion. In many of these cases remodeling the breeching, or perhaps the entire gas passage, will make the stack ample for average conditions and it may give some leeway for different qualities of fuel or a thicker fuel bed.

Of late it has been considered good practice to reduce the number of boilers on one stack and to replace right-angle turns with sweeping bends where the uptake enters the breeching and at the juncture of the breeching and the stack. This lessens the drop from the interference of gases and the eddying caused by a right-angle turn. In some recent plants the breeching has been eliminated entirely. An uptake covering two boilers leads to a stack at the center. There is no run of breeching to cut down the draft, no turns to cause further reduction, and interference is eliminated as the gases, when they meet, are flowing in the same direction into a stack of ample area. Outside of the stack the resistance is limited to the setting, and with proper design this may be low, so that the greater part of the draft produced is available over the fire.

With such construction there is no occasion for a high stack when the fuel is to be burned at ordinary rates of combustion. In plants subject to sudden and large demands of steam, making it necessary to run the boilers for a time at 200 to 300 per cent. of rating, an intense draft and a high stack to produce it will be required. Most of the draft, however, will be available over the fire, and in periods of normal load it can be held in check by dampers.

Often in an existing plant an investigation of draft conditions will save the installation of a new boiler. The matter is not of such minor importance as the individual losses would indicate. It is important then to get the draft down to the fire, where it is needed. Keep down the resistance in the breeching and setting and make the stack as effective as possible.

Steam-Electric Power Plant at Hauto, Penn.--IV

By Warren O. Rogers

SYNOPSIS—Energy from the turbo-generators is raised from 11,000 to 110,000 volts by means of oil-insulated water-cooled transformers placed in fireproof compartments. A portion of the energy developed at the power station is used, at 11,000 volts, for local service at the mines. There are remote-control oil switches on the 11,000- and the 110,000-volt circuits. Electrical energy is transmitted 26 miles to the Siegfried substation, where it is stepped down to 22,000 volts for commercial use.

Electrical energy from the Hauto power plant is transmitted to a substation at Siegfried, Penn., at 110,000 volts. The distance is 26 miles and the current is sent over duplicate three-cable circuits supported on a line of steel towers spaced about 600 ft. apart. Anchor towers are placed at all turns in the line and about every half mile on a straight line. Each transmission circuit consists of three standard copper cables, each 250,000 circ. mils, or about 5/8 in. diameter. The three cables of each circuit are placed one above the other in the same vertical line, the distance between each being 10 ft., with the bottom cable never less than 22 ft. from the ground. They are supported by suspension insulators, each consisting of six 10-in. disks. At the anchor towers the cables are anchored by two strings of seven-unit insulators yoked together for greater mechanical strength. At every third tower, as a precaution against the cables sagging when loaded with frozen sleet, two sets of insulators are hung at 45 deg. from the vertical.

At the substation the electrical energy is reduced by means of step-down transformers from 110,000 volts to 22,000 volts, at which pressure it is delivered to the distributing circuits and transmitted to the power customers.

As stated in a former article, energy is generated by the turbo-generators at 11,000 volts and is delivered to the low-tension busbar through circuits which include impedance coils for the protection of the generator in case of short-circuits. The 11,000-volt busbars are placed in brick-inclosed cells, as shown in Fig. 25. Fig. 26 is a view of the oil switches and circuit-breakers used for controlling the 11,000-volt circuits. The oil switches are directly above the busbar compartments, and on a level with the turbine-room gallery.

From the generator busbars two circuits are tapped off, one feeding the three transformers and the other connecting with an 11,000-volt loop bus. The low-tension busbars are connected in a loop and provision has been made for a loop bus for the 110,000-volt circuits when more units are added.

The 110,000-volt transfer bus is so arranged that any outgoing feeder may be connected to any set of transformers, or two or more feeders may be connected to one or more sets of transformers. Two auxiliary 11,000-volt busses supply energy to the auxiliary motor circuits in the power house as well as the local load in the vicinity of Hauto.

Both switches and circuit-breakers which control the 11,000-volt and the 110,000-volt energy are controlled and operated electrically with current supplied by storage batteries at 125 volts.

All 11,000- and 110,000-volt oil switches are controlled from a benchboard on the turbine-room gallery. All

power circuits are reproduced diagrammatically by dummy busbars and miniature switches mounted on the main benchboard. The position of each switch is indicated by a pilot lamp on the benchboard in the dummy system, a green light signifying that the switch is open and a red light that it is closed. This gives the operator an exact representation of the existing connections of the power circuits between the alternators and the busbars and between the busbars and the transmitting circuits.

On suitable panels behind the benchboard are instruments for recording the power voltage, current, frequency and power factor of the various circuits.

There are nine oil-insulated, water-cooled transformers, each of 3350-kv.-a. capacity, for raising the potential from 11,000 to 110,000 volts; each is in a fireproof compartment. The low-voltage leads come through the wall from the 11,000-volt bus compartments and the high-voltage conductors pass up through the ceiling to the high-potential switches and bus room. Each transformer is provided with wheels which rest on a track to facilitate

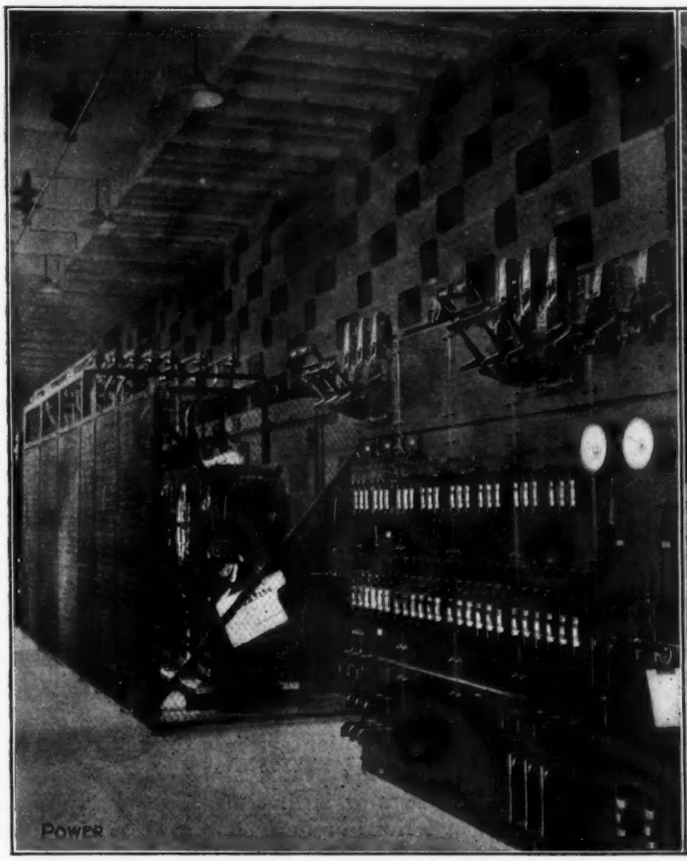


FIG. 25. LOW-TENSION BUSBAR COMPARTMENTS AND STATION SWITCHBOARD

FIG. 26. LOW-TENSION OIL SWITCH AND CIRCUIT-BREAKER ROOM

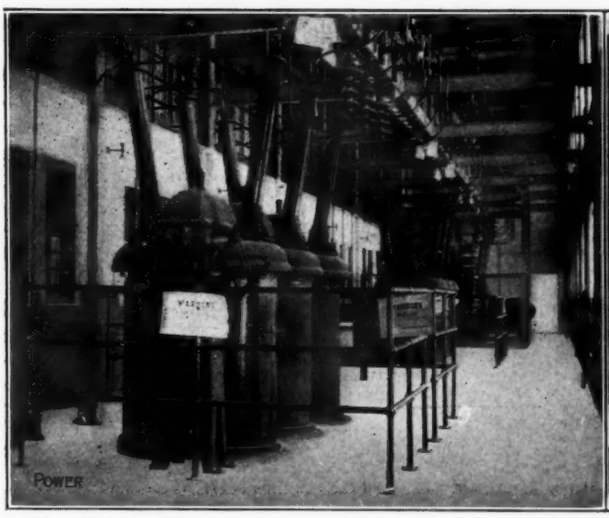


FIG. 27. SINGLE-PHASE 110,000-VOLT OIL SWITCHES AND HIGH-TENSION BUSBARS

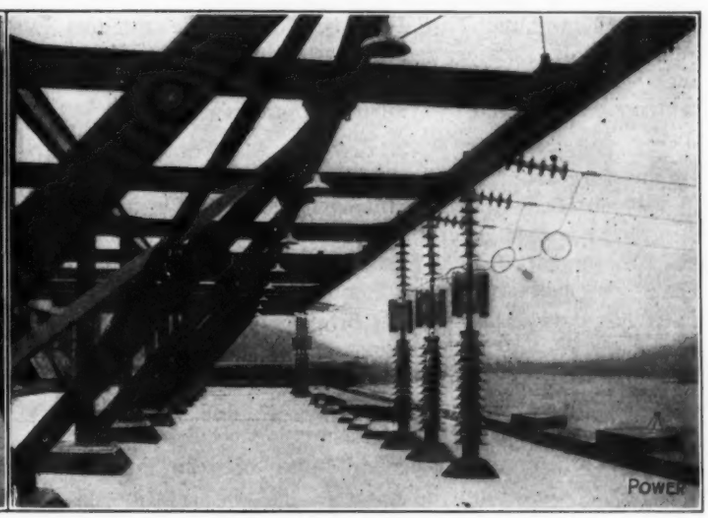


FIG. 28. METHOD OF INSULATING THE OUTGOING HIGH-VOLTAGE LINES AND THE ANCHOR FRAME

moving the transformer. Outside the building there is a track along the length of the building on which a transfer car runs, the top coming level with the floor of the transformer room. This arrangement provides means for the ready removal and installation of any transformer. Each group of three transformers is capable of delivering in continuous service 10,000 kw.

Each transmitting circuit has a set of three single-phase, 110,000-volt oil switches, Fig. 27. These are in the high-tension switch room above the transformer room and on a level with the floor of the low-tension circuit-breaker and oil switches. The high-potential conductors are of 1-in. brass tubing, carried on porcelain insulators and separated not less than 3 ft. from every part of the building except where they pass through the floor and the roof of the high-tension busbar room; here the conductors are insulated by special bushings.

The method of insulating the high-tension outgoing lines where they pass through the roof is shown in Fig. 28, also the massive construction of the anchor frame, erected on the roof of the high-tension switch room. Choke coils are shown between the two vertical strings of insulators.

Each conductor of the transmission circuit is equipped outside of the power house with a lightning arrester of the electrolytic, horn-gap type. These arresters are at the foot of the first dead-end tower. The small arresters are connected to the 11,000-volt circuits supplying electrical energy in the near vicinity of the power plant; the larger arresters, to the 110,000-volt transmission lines.

Twenty-five-cycle energy is transmitted to the Siegfried substation from the Hauto plant over the double-circuit, 110,000-volt transmission line. From the substation two double 22,000-volt circuits extend to Martin's Creek and Coplay. The Martin's Creek line is built for 110,000 volts as far as Nagareth in anticipation of a substation near this point when the load requires it. There are also two 11,000-volt lines running to Lansford, Penn.

Ammonia Condensers--III

By Fred Ophuls

SYNOPSIS—In the Sept. 2 and 30, 1913, issues of Power, *the various types of ammonia condenser in common use were described. The present article points out distinctive features of these condensers and touches briefly on their relative efficiency as cooling and liquefying apparatus.*

The general law which describes the heat-transfer phenomena in a condenser states: The heat rejected in a given time into the cooling water is equal to the product of the square feet of effective cooling and condensing surface; the rate at which heat is transmitted through a square foot of this surface in a given time for each degree of mean temperature difference between the ammonia and the cooling water, and the mean temperature difference between the ammonia and the water. This general law can be expressed in symbols as follows:

$$H = S \times k \times t_d \qquad (1)$$

In this formula

H = Heat rejected by the condenser into the cooling water, generally expressed in B.t.u. per hour;

S = Square feet of effective cooling and condensing surface;

k = Rate of heat flow in B.t.u. per sq.ft. of effective cooling and condensing surface per hour per degree Fahrenheit mean temperature difference between the ammonia and the water (called the heat-transmission coefficient);

t_d = Mean temperature difference between the ammonia and the water.

The total heat H rejected from the condenser per hour is made up of heat quantities rejected during three distinct changes in the state of the ammonia. Two of these heat quantities can be practically zero in certain types of refrigerating systems and specially designed condensers. The three heat quantities are the following:

(1) The heat removed from the superheated ammonia gas as it enters the condenser in cooling it to a saturated vapor at the ammonia pressure in the condenser.

(2) The heat removed from the saturated vapor in liquefying it at the temperature of saturation.

(3) The heat removed from the liquid ammonia in cooling it below the temperature of saturation, or liquefaction.

In the ammonia-absorption system in which, for economical reasons, the superheated ammonia vapor as it passes from the generator is first made to flow through a rectifier or dehydrator to reduce or practically eliminate the water vapor, the resulting anhydrous ammonia vapor is reduced to within a few degrees of the temperature of liquefaction. For this reason, the amount of superheat removed in a condenser of this system is so small compared with the heat of liquefaction that it can be neglected.

An ammonia condenser can be so designed that the final temperature of liquid anhydrous ammonia leaving it is practically the same as the temperature of liquefaction, so that there is practically no heat removed from the liquid ammonia. A condenser designed for liquefaction only is a special apparatus, applicable for use in special cases, and while it would be more simple to analyze than one embodying all the changes in the state of the ammonia, the more complicated apparatus is a better example of actual practice.

Equation 1 can be amplified by dividing the total heat quantity H into its constituent elements, as stated below in equation 2.

$$H = H_s + H_l + H_f = S \times k \times t_d \qquad (2)$$

In this equation

H_s = Heat of vapor superheat;

H_l = Heat of liquefaction;

H_f = Heat of liquid forecooling.

For comparing the magnitude of these values, the following figures may be given as representing a common condition of operation:

Condenser or liquefying pressure, lb. gage per sq.in.	184
Temperature of superheated ammonia entering the condenser, deg. F.	250
Temperature of liquid ammonia leaving condenser, deg. F.	90

For these conditions of operation, the heat removed

from the condenser per pound of ammonia liquefied will be as follows:

H_s	= (250 — 95) × 0.53 =	82.2 B.t.u.
H_l	=	495.3 B.t.u.
H_f	= (95 — 90) × 1.1 =	5.5 B.t.u.
Total heat removed.....		583.0 B.t.u.

To show the heat and temperature distribution as commonly found for some of the condenser types described and illustrated in these articles, the heat-distribution diagrams in Figs. 1 to 4 are shown. In these diagrams, horizontal distances represent quantities of heat in British thermal units per pound of ammonia liquefied and the vertical distances the temperature changes in degrees Fahrenheit of the ammonia in the condenser and the water used for cooling and liquefying it.

Fig. 1 shows the heat distribution for simple open-air ammonia condensers, as in Figs. 1 and 2 of the article appearing Sept. 2. In this type of condenser, the hot ammonia gas enters the condenser at the point where the cooling water is showered over it. This condition is illustrated by the points *a* and *e*, Fig. 1, the zigzag line *abcd* representing the temperature change in the ammonia, and *ef* that of the cooling water.

As the ammonia and water flow downward, the ammonia is cooled to the liquefaction point at *b* and the water rises in temperature to the point *g*. At *b* the ammonia is in the form of a saturated vapor and in its flow further down through the condenser it is liquefied, until finally at *c* all the ammonia is liquid. During the liquefaction period the temperature of the water rises from *g* to *h;* after this, if the liquid ammonia has not reached the outlet from the condenser, it will be further cooled by the water to the temperature *d* and the temperature of the water will rise to *f*.

Applying to this diagram the heat quantities given and assuming that the superheated ammonia gas enters the condenser at 250 deg., that liquefaction takes place at 95 deg. F. and the liquid is undercooled 5 deg., it will be found that if 2 gal. of 70-deg. cooling water are showered over the condenser per minute per ton of actual refrigerating effect of the system, its temperature at the end of the superheat period will be 72.1 deg.; at the end of the liquefaction period 84.85 deg.; at the end of the liquid-forecooling period 85 deg.

Having determined this temperature change, the logarithmic mean temperature difference for each period can be calculated. In this case it is 76.8 deg. for the superheat period, 15.8 deg. for the liquefaction period and 7.3 deg. for the liquid-forecooling period.

As the ammonia during the superheat period is gaseous and during the liquid-forecooling period a liquid, the heat-transmission coefficient for these periods is far less than for the liquefaction. However, the quantities of heat removed are also small, and for this reason a proper basis for the comparison of condenser performance can be obtained by assuming the heat-transfer coefficient constant for the three changes in the state of the ammonia. With this assumption, it is possible to find the combined mean temperature difference for the three periods by use of the following formula

$$t_{dm} = \frac{H}{\frac{H_s}{t_{ds}} + \frac{H_l}{t_{dl}} + \frac{H_f}{t_{df}}} \qquad (3)$$

In this equation the subscripts *s*, *l* and *f* indicate the superheat, liquefaction and liquid-forecooling periods, respectively.

From this equation we find for the conditions represented in Fig. 1 a combined mean temperature difference of 17.5 deg. F.

Fig. 2 shows the temperature and heat distribution for the open-air, double-pipe and spiral-coil condensers of the counter-current type illustrated in Figs. 3, 4, 7, 8, 9 and 10 of the previous articles when supplied with the same quantity and temperature of cooling water used for the simple open-air condenser. The combined mean temperature difference in this case is 13.8 deg. F.

To a casual observer it would appear from these results that for the same square feet of effective cooling surface the condensers from which Fig. 1 was plotted would give a greater condensing capacity than those to which Fig. 2 refers. This, however, is not the case, for the following reasons:

From equation (1) it will be seen that the mean temperature difference is not the only determining factor in the transfer of heat, but that the magnitude of *k* is just as important. From a condenser in which the combined mean temperature difference is small, just as much heat can be rejected as from one where the combined mean temperature difference is large, provided the value of *k* is larger in the former than in the latter case. Experiments have shown that the value of *k* varies as the square

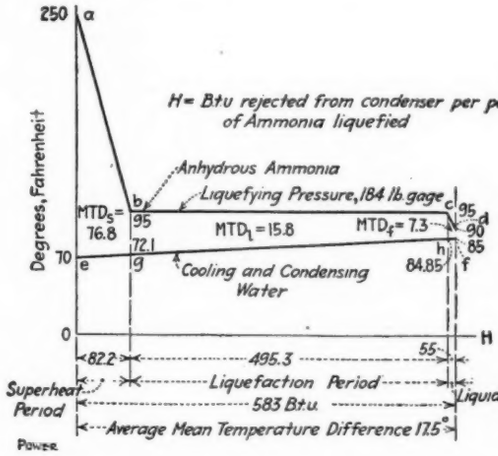


FIG. 1. HEAT-DISTRIBUTION DIAGRAM FOR OPEN-AIR AMMONIA CONDENSERS

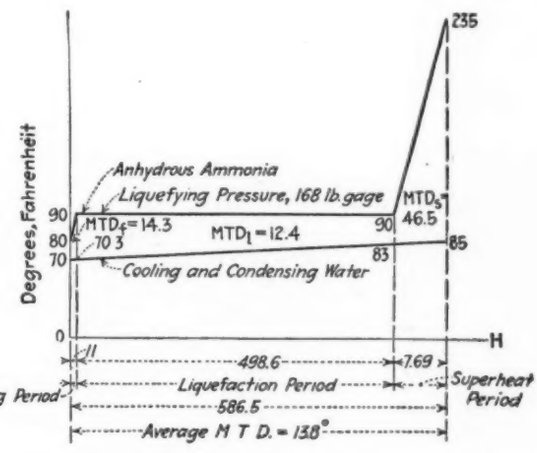


FIG. 2. HEAT-DISTRIBUTION DIAGRAM FOR DOUBLE-PIPE AND SPIRAL-COIL CONDENSERS

root of the average mean speed of the fluids in the condenser. The fact is that in the condensers for which Fig. 2 shows the heat distribution, the mean velocity of the vapor and the efficiency of the condensing surface is greater than in those to which Fig. 1 refers. The result is a lower liquefying pressure and a lower final liquid temperature for the same quantity and temperature of cooling and condensing water. The use of this type of condenser affects the efficiency of the refrigerating system as a whole in two ways. The greater forecooling of the liquid results in a reduction in the weight of refrigerant that must be circulated per ton of refrigeration produced and the lower liquefying pressure results in a smaller steam consumption for operating the refrigerating machine.

Fig. 3 shows the temperature distribution for the atmospheric condensers illustrated in Figs. 5 and 6 of the article appearing Sept. 2. It will be seen that their construction, while not as good as that of the condensers illustrated in Figs. 3, 4, 7, 8, 9 and 10, is better than that of the simple open-air condensers.

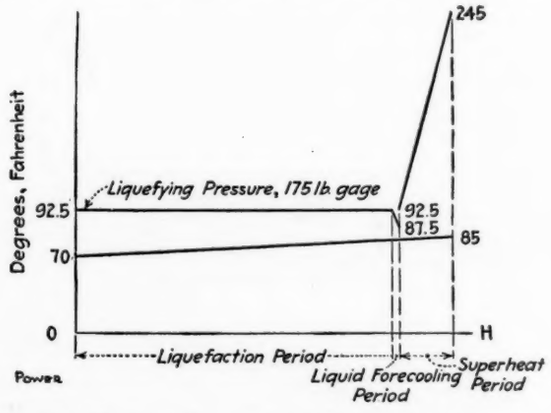


FIG. 3. HEAT-DISTRIBUTION DIAGRAM FOR ATMOSPHERIC CONDENSERS, TYPE C

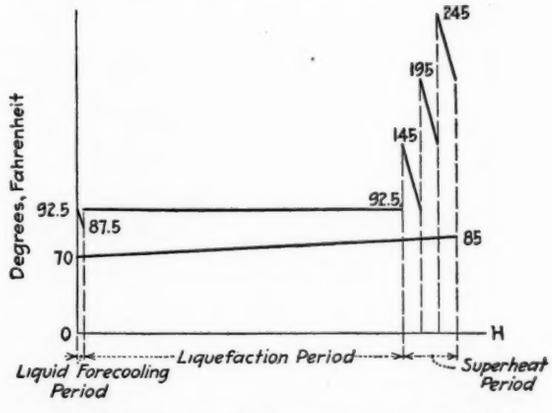


FIG. 4. HEAT-DISTRIBUTION DIAGRAM FOR DOUBLE-PIPE AMMONIA CONDENSERS

Fig. 4 shows the temperature distribution for a double-pipe ammonia condenser in which the ammonia headers and water headers are located at the opposite ends of the apparatus. This construction produces parallel flow in the same direction for the ammonia and water in each pipe, whereas the general flow through the condenser of the ammonia and water is counter-current. This condition of operation is indicated by the broken line showing the temperature changes in the ammonia.

A general equation giving the value of the heat-transmission coefficient for condensers is as follows:

$$k = a\sqrt{v}$$

where

a = Constant which must be determined by experiment for each type of condenser;

v = Average mean speed of the ammonia and water in feet per second.

Contrary to the ideas generally advanced in steam practice, the velocity of the ammonia vapor in this type of condenser affects the value of k. Experiments made at the works of the De La Vergne Machine Co., New York City, have shown that for open-air condensers, where the water flows perpendicularly to the ammonia vapor, the value of k is almost entirely dependent on the speed of the vapor in the condenser and, so far as could be determined, independent of the speed of the water.

For double-pipe condensers and other types in which the ammonia and water flow in parallel currents, and either in the same direction or counter-current, the value of k varies directly as the square root of the mean average velocity of the two fluids.

These statements can be readily proved without giving actual figures of test results, for Louis Block found some time ago that by throttling the inlet valves of ammonia condensers so that the valve was barely open, as good, if not better, results were obtained. The reason for this is that when these valves are wide open, the pressure in the condenser is nearly that in the discharge pipe, and on account of the large area of the condenser pipes, the average velocity of the vapor in the condenser is low. This velocity directly affects the value k and a large temperature difference is necessary to produce results. On the other hand, if the inlet valves on the condensers are throttled, the pressure in the condenser itself falls considerably below the pressure in the discharge pipe and the vapor speed in the condenser will be considerably increased, raising the value of k and improving the results, even though the mean temperature difference with the valves partly closed will be less than when they are wide open. Therefore, by so regulating the inlet valves of the ammonia condenser, a point can be found where the ammonia-discharge pressure and the final fluid temperature will be a minimum.

In Fig. 6, in the Sept. 2 issue, a special type of open-air ammonia condenser was illustrated. This condenser is equipped with an ejector A, which is ostensibly used for mixing some of the liquid ammonia condensed with the discharge vapor coming from the compressor before it passes to the top of the apparatus. It is claimed that the mixture of vapor and liquid will result in a better heat transfer in the apparatus than could be obtained with the vapor only. This statement is contrary to the laws of heat transfer, and if this condenser produces better results than a well constructed apparatus on the lines illustrated in Figs. 3, 4, 7, 8, 9 and 10, it is only due to the resulting increase in circulation in the condenser. The fact is, that in all condensing apparatus, whether used for steam or any other condensible vapor, the best results are obtained with constructions in which the liquid condensed is removed as soon as formed.

The Block type of ammonia condenser, Fig. 4, is a modification of the De La Vergne open-air condenser,

Fig. 3. The advantage of the former construction lies entirely in the better forecooling of the ammonia liquid before it flows to the liquid receiver. The construction otherwise is not ideal as a condensing apparatus, because all the liquid must pass up through all the condenser pipes before it can be discharged into the liquid receiver. The claim for the efficiency of this condenser is the same as that made for the atmospheric condenser shown in Fig. 6. Experiments have shown that the increase in efficiency of this condenser over the simpler open-air condenser is entirely due to the higher average speed of the vapor. The liquid, if not removed as soon as formed, fills up part of the space in the pipes and restricts the available area for the flow of the vapor, so that the average speed of the vapor is maintained nearly constant throughout this condenser. For condensers where the liquid is drawn off at various points, the speed of the vapor decreases as more and more of it condenses. On the other hand, in the latter type there is more surface available for condensation, so that actually this type of condenser, if properly designed and installed, will give better results than any other type heretofore described.

Theoretically, there is no difference between the operation of the Block type and the standard double-pipe type of ammonia condenser illustrated in Fig. 8 of the article appearing Sept. 30, except that in the former the ammonia vapor passes up through the condenser, whereas in the latter, the vapor enters at the top and the liquid is drained off at the bottom.

The spiral-coil type of surface condenser illustrated in Figs. 9 and 10 have been used largely in connection with absorption refrigerating machines and have proved efficient. The only objection to their use is the difficulty of cleaning the spiral coils of scale deposits, particularly when the quality of the cooling and condensing water is such that at the temperature in the condenser a hard scale is formed.

These condensers are so constructed that the liquid drains from the cooling surface practically as soon as formed, and, therefore, are of a construction which conforms to the best practice as indicated by theory. If this design were so improved that the velocity of the ammonia vapor would be greater than is the case in the construction at present used, better results could be obtained. As they are now constructed, the value of the heat-transmission coefficient k varies almost entirely with the speed of the cooling and condensing water through the coils for the reason that the speed of the ammonia vapor is small.

Fig. 11, in the Sept. 30 issue, illustrates an application of the standard steam condenser for use in liquifying ammonia. In this type, the velocity of the ammonia vapor is also small as compared to the speed of the water flowing through the tubes, and for this reason the value of k varies as the square root of the speed of the water, being practically independent of the speed of the vapor.

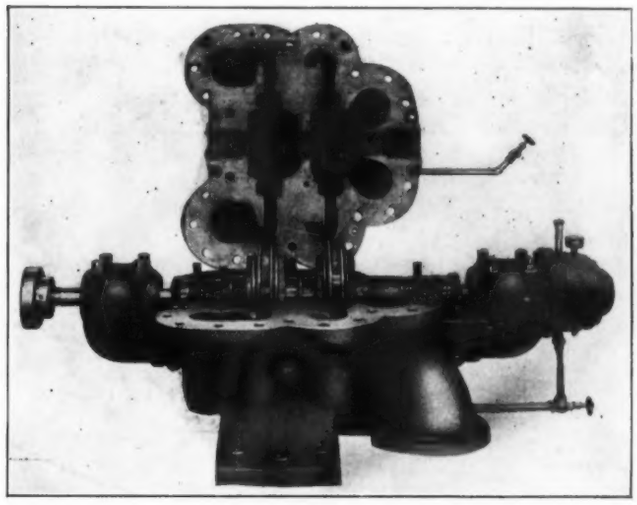
Figs. 12, 13 and 14 illustrate types of submerged ammonia condensers and but little test data are available on which to analyze their efficiency. They are at this time not much used, as a great deal of cooling and condensing surface is necessary in their construction to obtain good results. This is largely due to the inefficient use of the cooling and condensing water. The cooling water has a tendency to short-circuit from the water inlet to the outlet, and on account of the large cross-section available for the water flow, the heat-transfer coefficient k is extremely small.

In conclusion, it is most important in designing an ammonia condenser to take into consideration the velocity of flow of both the cooling and the condensing water and the ammonia vapor. Further, the best results are obtained if the liquid is removed as soon as formed. There is, of course, a limiting speed for the flow of the water and the ammonia vapor in condensers, and this limit is found in the pressures required to produce this flow. Depending on the cost of power and the first cost of installation, the limits will vary to some extent. The cheaper the power, the higher will be the limiting speed for the water and the vapor.

Goulds Centrifugal Fire Pump

A new two- and three-stage centrifugal fire pump, designed to work against 100 lb. pressure, has recently been put on the market by the Goulds Manufacturing Co., Seneca Falls, N. Y. The pumps are designed to discharge into hose lines or for service with automatic-sprinkler systems.

The casing consists of two castings horizontally divided



Centrifugal Pump with Casing Lifted

on a plane passing through the center of the shaft, as illustrated. Both the suction and the discharge nozzles are cast integral with the lower half. The upper and lower halves of the casing are bolted together and maintained in alignment by means of tapered dowel pins. Removing the upper half of the casing permits of inspecting the impellers, the shaft and the water passages.

The impellers are made of phosphor bronze, and have vanes of a shape to gain the highest efficiency when operating under the conditions for which the pump is built; they are of the nonoverload type. The hubs are fitted with removable and renewable composition wearing rings which reduce leakage to a minimum from the discharge side back to the suction side, and may be replaced when worn. The shaft bearings are of anti-friction metal, made in halves, divided on the center line, and may be removed and renewed by taking off the upper half of the bearing shell.

The stuffing-boxes are fitted with split bronze glands

so designed that the water leaking through them cannot be thrown off from the shaft, but is drained into the drip pockets. The stuffing-box on the suction side of the pump has a bronze lantern water-sealing ring, through which water from the pressure side of the pump is piped, thus preventing the entrance of air into the pump.

Diesel Engines in Marine Work

The following is from a letter by a correspondent who has been chief engineer of a Diesel ship for the past eighteen months. While this particular ship has been regarded as eminently successful it has not been free from engine troubles, but these are slowly being eliminated. As expressed by the writer, "Diesel engines have come to stay and it behooves marine engineers to study them."—EDITOR.

The vessel, the machinery of which I have charge, has been in service for 18 months, the latter part of this period with considerable success. The propelling machinery consists of two single-acting, four-stroke-cycle, open-frame type Diesel engines of six cylinders each, with a diameter of 22 in., and 39-in. stroke. Although designed for about 1100 brake horsepower each, the engines indicate approximately 2700 hp. combined.

Difference of opinion exists among engineers as to the type best suited to marine work; some prefer the open frame, others the closed-in type. With the latter, of course, a clean engine room is possible, while with the former it is impossible to prevent the lubricating oil splashing onto platforms, gratings, etc., due to the high speed of the engine. Still, from a practical point of view, the open type is preferable as the bearings can be felt by the engineer and any slacking back will probably be noticed in time. Also, in overhauling, it is much simpler and quicker, and builders of this type try to conform as nearly as possible to ordinary steam-engine practice.

As regards the engine operation, the exhaust valves are generally looked upon as a weak part and require constant overhauling. On several occasions we have had the valve spindles and their guides break. This was due to the rubbing surface being too soft and not sufficiently lubricated, at the same time working too hot. It was remedied by fitting hard-steel bushings, both on the guides and spindles, by a more efficient means of lubrication and by fitting an internal pipe to insure the lower part of the chest being cooled. Since then no trouble has been experienced; yet we find it advisable to take the valves and chests out every few weeks and replace them with spare ones, a full set of which should always be carried, those taken out can then be put in order at sea. Moreover, due to working at such high temperatures, the valves and seats are apt to become warped.

The air-inlet valves give little or no trouble, neither do the fuel valves if they are not allowed to become dirty, and care is taken that the fuel is well filtered. The small valves, which automatically release the compression in the cylinders while maneuvering, must be carefully watched for dirt; a little on the spindles or valves causes them to stick, with consequent difficulty in getting the motor started.

The cylinders themselves should be well water jacketed, especially the heads. Many cylinder heads have been cracked through faulty circulation, because the valves were too crowded, leaving no space for the water to get through. This has been remedied in our case by placing the fuel valve out of the center, thus giving more freedom for the water to circulate.

Another source of trouble was the pistons, which are water cooled, the inlet and outlet being through telescopic pipes fastened on the bottoms of the pistons and working with them. Owing to the long stroke, it is difficult to keep these pipes working true, but we have now made the outer pipes, in which the telescopes work, larger in diameter to allow of more movement. Several pistons were cracked by the cold water striking directly against the hottest part. This was remedied by fitting deflecting plates inside, which forced the water to take a circular direction, the cooling then being more gradual. The pistons are about 12 in. long, each fitted with eight ramsbottom rings, with a broad white metal band on the lower part to insure a working fit in the cylinder. If not well lubricated, the rings give a lot of trouble, get fast in the grooves and in a short time are burned solid; which means that they have to be cut out with a hammer and chisel. The rings should be an easy fit in the grooves and there should be efficient lubricating pumps for forcing the oil. Then the wear on the cylinder walls will be slight. In this design, the piston is examined from the bottom, so that no shafts, levers or pipes need be disconnected, which means a great saving in time, in fact, a piston can be examined in less than an hour.

Another important part of a Diesel-engine equipment is the air-compressing plant. This in the present case consists of a three-stage compressor driven by balance levers from the main engines. The compressed air is discharged at each stage through copper coils placed in one of the main columns through which water is continually circulating, to insure the air being well cooled; the compressor pistons are very long and are lined, above the ramsbottom rings, with white metal, thus insuring a neat fit in the cylinders. Here, again, good lubrication is essential to avoid trouble. The valves must be examined and cleaned as often as possible; if allowed to get dirty, they quickly become baked. The cooling coils also give trouble at times, being liable to crack at the neck of the flange, due to the expansion and contraction. These should be washed out occasionally with benzine to get rid of the oily deposit from the lubricant, a little of which is sure to find its way in with the air, and it may have disastrous results—in fact, most of the explosions recorded of Diesel motors have been due to this cause—so that too much care cannot be used with the compressing plant.

It will be seen from what has been said that many spare parts must be carried, especially on a vessel making a long voyage.

The fuel oil used is ordinary Roumanian or American gas oil with a specific gravity of 0.890 at 15 per cent. and a flash point of 80 deg. C. In regard to the lubricating oil, only the best should be used. Inferior oils are not recommended as they give trouble, and animal oils, above all, should be avoided. We now use one kind

and quality only for all purposes of lubrication, instead of three as before; this is much to be preferred as a mistake is so easily made. Following are specifications of the oil used:

Viscosity at 50 deg.	10.5
Flash point	215 deg. C.
Specific gravity at 15 deg.	0.92

It should be mentioned that all the auxiliaries are steam driven, one oil-fired boiler being fitted on deck for port use and a smaller one in the engine room for use at sea. Firing is accomplished partly by oil and partly by the exhaust gases from the engines. The boiler is of the ordinary marine type, having two furnaces, so that the gases are continually passing through one furnace, to act, in the first place, as a silencer, and in the second to utilize the waste heat from the exhaust. The second furnace is free for an oil burner, but we find it unnecessary, as with the steering and other small engines usually working at sea, sufficient steam to drive them is generated by the exhaust gases alone, which is a great saving.

In conclusion, it is my opinion that a great deal yet remains to be done before internal-combustion engines for ship propulsion have the reliability of the steam engine. However, progress will undoubtedly be made, and it behooves marine engineers to study the question, as Diesel engines have come to stay.

Calculating Evaporation Costs

By Theodore Maynz

SYNOPSIS—A set of charts for readily figuring the cost of coal, labor and ash removal per 1000 lb. of evaporation.

Engineers and engineering salesmen often need to make rapid calculations on the cost of coal, labor and ash disposal. To do this rapidly on a slide rule may give rise to errors, especially in decimal places.

The best basis for calculating power costs is probably

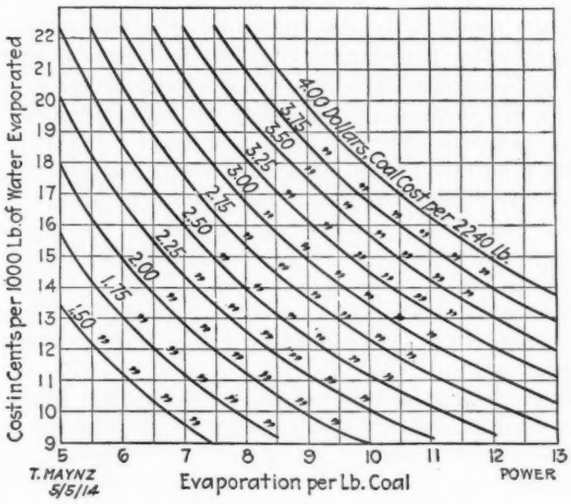


Fig. 1. Cost of Evaporating 1000 Lb. of Coal with Different Priced Coals and Different Boiler Efficiencies

on 1000 lb. evaporation. From this the total cost per annum may easily be figured, either from the total water records or, if these are not obtainable, from the total coal and the approximate evaporation per pound of coal.

$$\textit{Total evaporation} = \textit{Tons of coal} \times 2240 \times \textit{pounds equivalent evaporation per pound of coal}$$

Using the first chart, by means of the evaporation per pound of coal and the cost of coal per 2240 lb., delivered in the boiler room or bunkers, the cost in cents for evaporating 1000 lb. of water is easily found.

The second chart shows the cost of labor in the boiler room per 1000 lb. evaporation. This cost is based on the total labor cost per 2240 lb. of coal fired, which is probably the easiest method of arriving at this figure.

$$\textit{cost of labor per ton of coal} = \frac{\textit{labor cost per month (or year)}}{\textit{tons of coal per month (or year)}}$$

The third chart shows the relation between the percentage of ash and refuse, the equivalent evaporation and the cost of ash removal per 1000 lb. of evaporation. A cost of 50c. per 2240 lb. of ash and refuse is the basis of cartage cost. Of course, this will vary in different localities, but this cost can easily be multiplied by some factor to take care of this difference, such as one-half cost from the chart, if the contract price for ash removal is 25c. per ton instead of 50c.

If the total ash and refuse is not obtainable, as may be the case when considering the change from one coal to another, the amount may be approximated from the coal analysis by multiplying the percentage of ash by 1.25, as this will be an average factor for fixed carbon and moisture in the ash as dumped from the furnace.

Criticism may be made that an evaporation of 10 to 12 lb. cannot be obtained with 20 to 36 per cent. ash and refuse. However, this part of the curves was put in only for convenience of extending the curves, and for keeping the chart uniform in appearance. The use of the curves is best illustrated by considering a complete problem.

A boiler plant using anthracite coal, hand fired and costing $2.50 per ton of 2240 lb. delivered; 1200 tons being used per month, at an average equivalent evaporation of 7 lb. per pound of coal, as fired. The operating labor is in three shifts, each consisting of two firemen and one coal passer, paid $2.50 and $2 respectively, seven days per week. The total ash and refuse is approximately 22 per cent., costing 40c. per ton for removal.

The use of soft coal and stokers is considered, the coal costing $3.50 per 2240 lb. delivered, the ash analysis being 8 per cent. An evaporation of 10½ lb. is guaranteed, the labor for operation being reduced to one fireman and one coal passer per eight-hour shift, at the same wage rate. What will be the cost reduction, if any?

Coal Cost: Anthracite at $2.50 per ton from Chart No. 1, and 7 lb. evaporation gives 16c. per 1000 lb.

Labor Cost: $7 per eight hours = $21 per day or $630 per month. The labor cost, per ton of coal, equals

$$\frac{630}{1200} = 52\tfrac{1}{2}\text{c.}$$

From Chart No. 2, interpolate between 50 and 60c. at 7 lb. evaporation and get 3.37c. as the cost per 1000 lb.

Ash Removal at 7 lb. evaporation and a charge of 50c. per ton and 22 per cent. refuse from Chart No. 3 is 0.7c.

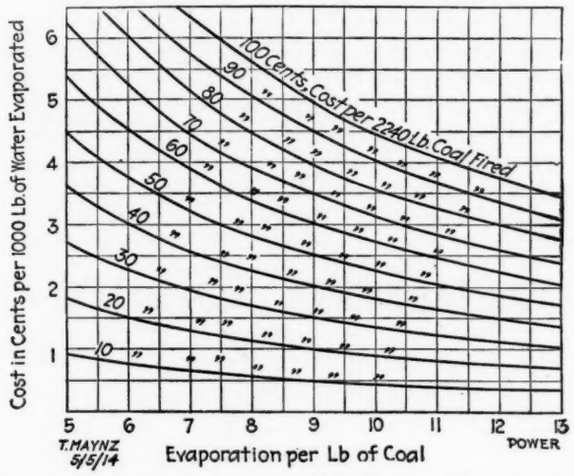


Fig. 2. Cost of Labor per 1000 Lb. of Evaporation

per 1000 lb. At 40c. per ton this will amount to $\frac{4}{8} \times 0.7 = 0.56$c. per 1000 lb. evaporation.

Therefore, the total cost for operation is,

	Cents
Coal	16
Labor	3.37
Ash	0.56
Total	19.93 per 1000 lb. evaporated

With stokers and soft coal, from Chart No. 1, with coal at $3.50 per ton and 10½ lb. guaranteed evaporation,

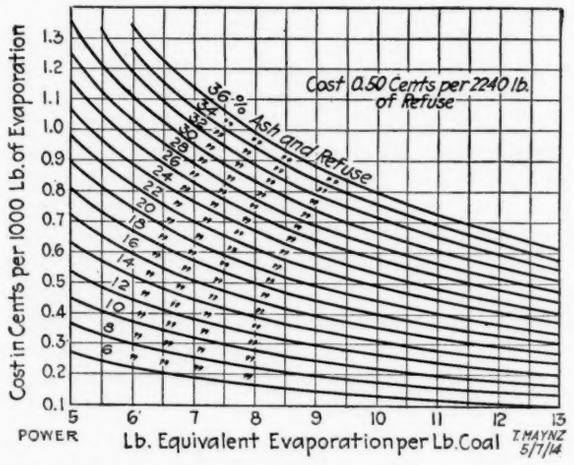


Fig. 3. Cost of Ash and Refuse Disposal per 1000 Lb. of Evaporation

the cost of evaporating 1000 lb. of water is 14.85c. The labor will cost $4.50 for 8 hr., or $405 per month.

With a new coal consumption of

$$1200 \times \frac{7}{10.5} = 800 \text{ tons}$$

per month, the labor cost will be

$$\frac{405}{800} = 50.6c.$$

per ton of coal fired. This combined with a 10½-lb. evaporation brings the labor cost to 2.2c. per 1000 lb. evaporation, obtained from Chart No. 2. From the coal analysis, the ash being 8 per cent., the total ash and refuse will be about 10 per cent. ($8 \times 1.25 = 10$) and under 10½ lb. evaporation, from Chart No. 3, the removal cost at 50c. per ton will be 0.21c. per 1000 lb. However, at 40c. per ton the cost will be 0.17c. per 1000 lb. evaporation.

The total operating cost per 1000 lb. evaporation would be

	Cents
Coal	14.85
Labor	2.2
Ash removal	0.17
Total	17.22

From these figures the percentage saving can easily be figured for the total or for each item, or the total cost per month may be quickly obtained.

Efficient Operation of Centrifugal Pumps

By Otto Haentjens

A well designed centrifugal pump in operation will not always be as efficient as was expected by the purchaser. The fault, however, in many cases is with the purchaser and not with the manufacturer.

Many engineers not familiar with centrifugal pumps make the mistake of allowing a substantial margin for safety when estimating the total head against which the pump has to work; although this is good practice with power pumps, it is absolutely wrong with centrifugal pumps. The manufacturer will build a pump that is most efficient at the capacity and head specified by the engineer. Supposing the engineer had estimated the total head to be 100 ft., but in operation it was found to be only 80 ft. The pump at this lower head would discharge much more water, and if this were not allowable and the speed of the motor could not be reduced, the discharge would have to be throttled, resulting in a decrease in efficiency of about 20 per cent. A more efficient way to correct the trouble is to turn down the impeller blades (not the side disks). The diffuser need not be changed.

If the head has been estimated too low, the repair becomes more costly, for besides a new impeller a new diffuser must be put into the pump. Therefore, the designer, as a rule, figures the impeller for a slightly higher head than was specified.

Every centrifugal-pump manufacturer impresses upon the purchaser the advantage of a low suction lift, tight suction piping with few bends and a slant toward the intake; yet one can find many installations where little attention has been paid to these rules. The result is poor working of the pump and a condemnation of the centrifugal pump in general.

Extreme lift or small suction piping with many bends, small foot valves and strainers cause a high vacuum at the impeller inlet. This low pressure is not sufficient to force the water at the required velocity into the impeller and the capacity and efficiency of the pump are reduced accordingly. The pump often loses the suction and has to be primed again.

Every centrifugal pump should be equipped with a vacuum gage which should be placed as close to the pump as possible. It is a good trouble indicator. If everything is all right in the suction line, the hand of the

gage will vibrate but slightly; if the hand oscillates violently back and forth, it is an indication of an air leak in the suction pipe. Air usually causes a rattling noise in the pump, but this also can be caused by the diffuser, it being either too small for the capacity pumped or the diffusion vanes come down too close onto the impeller. It is good practice to have ¼ in. clearance between the impeller, and in the volute pumps without diffusion rings, the clearance between the impeller and the neck on the outlet branch should be from ¾ to 1 in. If it is less, the pump is liable to be noisy. Noisy pumps are always less efficient and should not be accepted by the purchaser.

If under normal conditions the suction gage shows, say, 10-in. vacuum, and the vacuum gradually increases and comes up to 15 or 18 in., it is time to clean the strainer and inspect the foot valve. The face area of a foot valve should at least be equal to the free area of the suction pipe and a strainer should have an area three to six times larger. If possible, a foot valve should be omitted as a defective valve can decrease the efficiency considerably.

The purchaser should insist that with the bid there should be submitted a characteristic curve showing the performance of the pump. If, for instance, the manufacturer guarantees a pump to have a capacity of 1200 gal. per min. against 200-ft. head and a best efficiency of 72 per cent., it does not mean necessarily that this efficiency will coincide with the capacity and head named. It may occur, when the pump discharges 1000 gal. per min. and the efficiency at 1200 gal. per min. may be only 68 per cent. The pump then will use about 6 per cent. more power than the purchaser figured on. A characteristic curve will show further to what extent the pump will overload the motor if the head on the discharge is diminished, as through a break in the pipe line. Twenty-five per cent. overload may be permitted, but not more, as some motors now on the market will not stand a larger overload.

Many engineers believe that a high-lift pump in order to be efficient must be equipped with diffusion rings. This is true for small capacities and high head per stage; for instance, it would not be advisable to use a two-stage pump without a diffuser to handle 300 gal. per min. against 400-ft. head, but if the head is limited to 150 ft. per stage, pumps without diffusion rings are very efficient. These pumps are usually built with a removable upper casing and permit easy access to the runners in case ships, stones or rags, etc., should have found their way into the pump and clogged up the impellers. Furthermore, the shaft and the impellers can be replaced in a very short time. This is important where no spare pumps are installed and a long shutdown would seriously interfere with the operation of the entire plant. Even if this type of pump should be a little less efficient than a pump equipped with diffusion rings, the advantages outlined above will in some plants offset this.

Analyzing an Existing Plant*

By Osborn Monnett†

SYNOPSIS—A study of breeching arrangement and loss of draft in a plant which could not develop normal rating without smoking.

In the last article a new plant was designed. It is frequently necessary, however, to study the draft conditions in a plant already in operation and point out the defects with the idea of improving conditions. In the accompanying illustration is shown a plant consisting of three 180-hp. horizontal water-tube boilers, vertically baffled, with mechanical stokers, on leg *A* of the breeching; one 500-hp. horizontally baffled water-tube boiler connected to branch *B* of the breeching, and two 150-hp. return-tubular boilers on branch *C*. The lengths of the different branches of the breeching are shown in the drawing. The grate surface and the dimensions of the damper openings and of the stack are also given. The problem is to determine what changes, if any, are necessary to better draft conditions.

The stack is 115 ft. high, making an available height over the breeching connections of

$$115 - 15 = 100 \text{ ft.}$$

with the arrangement of breeching shown, it would not be reasonable to expect a temperature of over 475 deg. at the stack. At this temperature 100 ft. of stack will give a draft of

$$100 \times 0.0065 = 0.65 \text{ in. of water}$$

Taking the straight run of breeching from the stack to boilers Nos. 2 and 3 as 50 ft., a draft loss of 0.1 in. can be assumed. Branch *B* will cause 0.05 in. additional loss. The right-angle bend at *K* will take off another 0.05 in., and for each of the uptakes of boilers Nos. 2 and 3, another 0.05 in. will be lost, so that in the breeching over the last boiler there will be

$$0.65 - 0.1 - 0.05 - 0.05 - 0.05 - 0.05 = 0.35 \text{ in.}$$

of draft. Below this uptake there is another right-angle turn before reaching the damper, so that a net draft at the damper of only 0.3 in. is obtained.

In the type of setting used on No. 1 boiler there is a draft loss of 50 per cent., so that the draft over the fire would be 0.15 in. Allowing 5 lb. of coal per boiler horsepower, at the normal rating of 180 hp., there will be

$$180 \times 5 = 900 \text{ lb.}$$

of coal burned per hour. The grate surface is 36 sq.ft. and the rate of combustion per square foot will be

$$\frac{900}{36} = 25 \text{ lb. per hr.}$$

Referring to the draft curve, Fig. 2, on page 808 of the June 9, 1914 issue, it will be seen that to burn this amount of coal smokelessly 0.26 in. of draft over the fire will be necessary. It is plain that it would be difficult to get rating on boilers Nos. 1, 2 or 3 without producing smoke.

In the breeching to the 500-hp. boiler there will be a loss of about 0.15 in., allowing 0.05 in. for the straight run, 0.05 for the entrance of branch *C* and 0.05 in. for the right-angle turn of branch *B*. The available draft,

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†Smoke inspector, city of Chicago.

then, at the damper of boiler No. 4 will be

$$0.65 - 0.15 = 0.5 \text{ in.}$$

As there will be a drop through this type of boiler of 65 per cent. this will give a net draft over the fire of

$$0.5 \times 0.35 = 0.175 \text{ in. of water}$$

At 5 lb. per horsepower the boiler will use

$$500 \times 5 = 2500 \text{ lb.}$$

of coal per hour. With 100 sq.ft. of grate surface the rate of combustion per square foot per hour will be

$$\frac{2500}{100} = 25 \text{ lb. of coal}$$

At this rate the draft should be 0.26 in., so that under the present arrangements good operating conditions at rated capacity cannot be obtained on this boiler.

Considering boilers Nos. 5 and 6, the draft at the stack side of the damper of the last boiler would be 0.40, assuming a 0.25-in. drop in the breeching. The loss is made up as follows: Stack to point *O*, 0.05 in.; turn into branch *C*, 0.05 in.; from point *O* to No. 5 boiler, 0.1 in.; drop due to No. 5 breeching connection, 0.05 in., making a total loss of 0.25 in. and reducing the available draft at the stack side of the damper of No. 6 boiler to 0.4 in. With proper furnace design, the draft loss in return-tubular boilers is 47 per cent., so that the net draft over the fire on these boilers is

$$0.40 \times 0.53 = 0.21 \text{ in.}$$

The grate surface is 36 sq.ft. and the coal consumption at rating will be

$$150 \times 5 = 750 \text{ lb. per hr.}$$

The rate of combustion per square foot of grate surface per hour will then be

$$\frac{750}{36} = 21 \text{ lb.}$$

This calls for a draft of 0.21 in. of water, so that the draft for these boilers at rating is satisfactory.

To improve the breeching layout, starting with boilers Nos. 1, 2 and 3, the uptakes into the breeching should be eased off into long sweep bends, doing away with the right-angle turns. The draft at this point will then be improved. The turn at *K* should also be changed to a long sweep bend. In calculating the height of stack necessary for normal rating or above, branch *A* can be taken as a basis, because if the draft can be increased sufficiently here, then the draft on the other branches will be satisfactory.

A draft of 0.3 in. over the fire would take care of

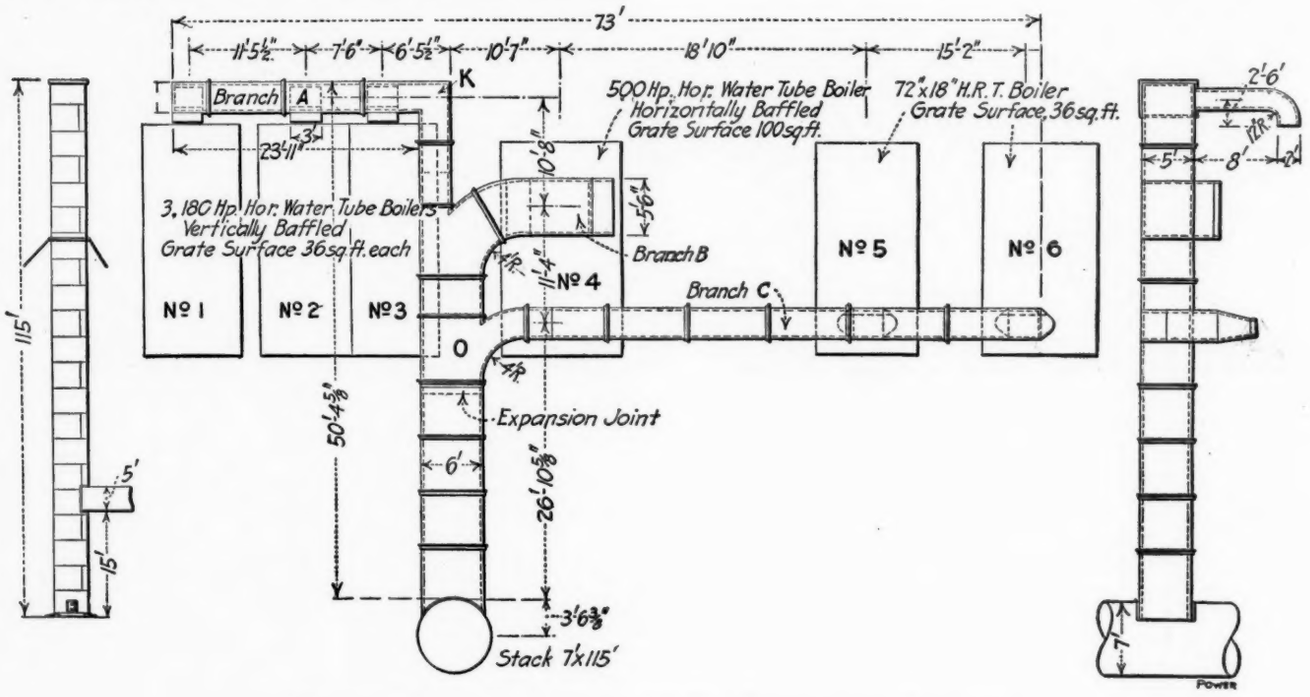
$$\frac{36 \times 28}{5} = 202 \text{ hp.}$$

an overload of 12 per cent. This would necessitate a draft of 0.60 in. at the damper of No. 1 boiler. With a 0.30-in. drop from here to the stack, the draft necessary at the stack connection will be

$$0.60 + 0.3 = 0.9 \text{ in.}$$

and the height of stack above the breeching connection must be

$$\frac{0.9}{0.0065} = 138.4 \text{ ft.}$$



SHOWING LAYOUT OF THREE 180-HP. BOILERS AND BREECHING

or practically 140 ft., making a total height of stack of

$$140 + 15 = 155 \text{ ft.}$$

above the ground. This would give rating on No. 4 boiler and some overload capacity on Nos. 5 and 6.

AREA OF STACK

The total connected grate surface is

$$36 + 36 + 36 + 100 + 36 + 36 = 280 \text{ sq.ft.}$$

With a 7-ft. stack the ratio of stack area to connected grate surface is 38.5 to 280, or 1 to 7.27. This is altogether too high, but as ordinarily there will be at least two boilers down, the ratio will be reduced to 38.5 to (280 — 72), or 1 to 5.4, indicating that the stack will probably be large enough for ordinary use.

The layout shown must not be taken as in any sense ideal. It is given merely to show what may be encountered in practice and to indicate the method of procedure in studying an existing plant.

Editorials

Boiler-Explosion Table

Years ago, POWER published certain statistics regarding boiler explosions and always has covered reports of the most important accidents. For some time it has been our ambition to get out a more complete compilation of such data, and, beginning with January, 1913, we commenced a systematic campaign to secure it. The first printed evidence of these efforts appears in this issue.

When this work was started we endeavored to bring every possible means to its assistance. Boiler-insurance companies were asked to coöperate. Our news correspondents, subscription agents and advertising solicitors were instructed to advise us of any boiler accidents coming to their knowledge. Finally, with the service of a number of clipping bureaus, we managed to get in touch with what we feel is a large proportion of the accidents to stationary boilers that have occurred in this country during the past year. A few marine boiler explosions have been covered, but all locomotive boiler accidents were omitted as not likely to interest many readers of POWER. By way of explanation, it may be added that the term "explosions" has been used in its strictest technical sense to cover any unintentional escape of steam and is not confined to such as cause total destruction or dislodgment of the boiler.

For the assistance we have received from various sources we wish hereby to acknowledge our indebtedness. We would mention these friends individually if space permitted, but for repeated favors we feel that special thanks are due to the Maryland Casualty Co., the Fidelity & Casualty Co. of New York, the Hartford Steam Boiler Inspection & Insurance Co., and the Globe Indemnity Co.

When we had learned of an explosion, our work had just begun. The source of the information never gave us all of the facts we wanted, so a post card was sent to some one in the vicinity of the explosion, asking that the blanks be filled. These blanks requested the information given at the heads of the columns of the table, including date, place, plant, time of day, kind of boiler, pressure carried, size, number killed, number injured, property loss and probable cause. Failing to get an answer to one card, a second was sent to someone else, and sometimes a third and fourth, or until as many as possible of the blanks were filled. In nearly all cases fifty cents was offered and paid for the return of each card, so it can be seen that in this item alone, the campaign was expensive.

It was with considerable chagrin that we found how spotted with blank spaces the table proved to be, for the accidents of which we were able to obtain full reports were in the minority. Another thing that has disappointed us was the delay in getting the table printed. We apologize for all these very evident defects, pleading only that the work was difficult and we were inexperienced. However, we feel encouraged to promise better next time, and it will be our aim to issue the table quarterly instead of annually, and with less elapsed time between the last accident and the appearance of the table.

We expected to present with the table some comments and summaries, but are compelled from pressure on our space this week to hold them over for a later issue. The table speaks for itself as to the lessons it teaches, and will get its message to those who are inclined to study over it a little.

As always, upon any innovation, we shall be pleased to have our readers' opinions. Criticisms as well as words of approval will be very welcome, if they will help us discover in what directions the table may be improved. Let us hear from a number what they think of the value of such a table. Possibly it will not appeal to enough people to warrant our continuing to collect the information, and if that is so we want to know it, and quickly.

If we are to continue it, the help of all our subscribers and friends will be appreciated. We cannot promise a half dollar to every one that sends in a post card concerning a boiler accident, for we might pay too many times for the same report. We will, however, gladly offer fifty cents for the first card that gives the most of the information before enumerated regarding any boiler accident.

The Breathing Bumped Head

Analogous to the danger which lurks in the lap-seam joint is that present in the bumped boiler head, another instance of the failure of which is recorded on page 911.

If a piece of boiler plate is clamped in a vise and the free end moved backward and forward, a fracture will eventually occur, not at the point of greatest movement, but where the external movement is arrested and the greatest molecular distortion necessary to permit that movement occurs.

A vessel under pressure tends to assume a form having a circular section. With a lap joint, the section of this shell is not circular. Internal pressure tends to stretch the joint in such wise as to bring its center line within the circle, and if the joint is sufficiently out of true to spring out again on the removal of pressure, there will be repeated distortion about a line of flexure which will eventually result in a crack hidden between the sheets which may work its way through until the remaining sound metal is insufficient to withstand the pressure and an explosion occurs.

Many of the most disastrous recent explosions have been produced in this way. Many lap-seam joints on boilers which have been cut up have shown incipient cracks of this kind. Many lap-seam boilers, on the other hand, have lived to a good old age without developing any such infirmity. The tendency to do so is increased by lack of ductility in the material, by the manner in which the edges of the sheet which are not curved by the bending rolls are brought to the curve of the boiler, by the departure from a true circle in the finished seam, by the pressure carried, and so forth.

It is possible that more refined methods of inspection may detect incipient failure or reassure as to the safety of specific examples of joints of this type. Mr. Jeter, the chief inspector of the Hartford Steam Boiler Inspection & Insurance Company, has suggested a method of slotting the exterior sheet, which will give an indication of the impairment of a joint from this cause. A description of this will appear in the next issue.

A boiler head under pressure tends to assume a hemispherical form. This tendency is met half way by bumping the head to a radius equal to the diameter of the boiler. If it were practical to meet it completely by making the heads hemispherical, the flanges by which they were attached to the shell would be tangential to their own curve and the ideal construction would be realized. As it is, there is an abrupt change of curvature where the flange is turned down, and if the plate is so light or is bumped to so large a radius as to be subjected to considerable flexure under pressure, the fiber stress due to that flexure will be concentrated at this point of sudden change and the metal in that line will be liable to the same cracks that have made the lap seam so dangerous. The crack extends around the heel of the flange and the center of the head comes out, breaking away from the flange usually in a clean circle.

This does not mean that all or most bumped heads are dangerous. The larger the head, the thinner and more brittle the metal, the larger the radius to which it is bumped, the more abruptly it is flanged, the greater the pressure and the more frequent the fluctuation in pressure the more dangerous it will be. Owners of shells with large heads bumped to a radius of more than their own diameter will do well to pay some attention to their behavior and condition.

The making of hemispherical heads for steel vessels under pressure, such as boiler drums, is too elaborate a process, and requires too expensive apparatus to warrant the individual boiler maker attempting it upon his own account; but makers of such vessels would doubtless be glad to be able to buy such heads ready made, and it is not unthinkable that some properly equipped steel works might turn them out in standard sizes at an advantage.

Machinist Engineers

Some exception we feel should be taken to the views expressed in the letter on the above subject, on page 930. While a sure-enough, up-to-the-minute knowledge of the machinist trade is not essentially a part of the stock-in-trade of the engineer, it is certainly to his advantage to know something not only of that craft but of the composition of iron and the process of molding, and how a pattern should be made so that it will "draw" from the sand. A knowledge of forging and tempering steel is almost indispensable in all but the largest plants, and not amiss in any. Similarly, the "first aids" to boilers must be performed.

It is conceded that steam fitting is a part of the engineer's work, therefore why should he not have a knowledge of the proper use of the machinist's tools? In fact, the more fully the engineer is informed in the lines so closely connected to his own everyday duties, the more likely is he to emerge from the oiler class and stay at the head of his profession. The respect of those with whom he comes in contact is gained by his intimate knowledge of their occupation or lines, and not by trying to impress upon them the greatness of his own. This holds good from shop boys to directors. One must know the other fellow's game to win out with him.

Certain it is that in either case, doing or supervising, the more positive the accurate knowledge, the more satisfactory the results. What is more humiliating to an engineer than to be obliged to stand aside in his own domain while a machinist from an outside shop steps in and "does things" which may or may not be done according to the best practice. Surely, there are opportunities in abundance to become so informed on the ordinary operations of the machine shop as to enable the engineer to do satisfactorily all the machine work of the plant.

Cheap Firemen

When a boiler is under test, those responsible for its performance are very much alive to the merits and demerits of the fireman. They will pay a fireman who can get results ten dollars or more a day, and be glad to get him.

And after the test is over, they turn the boiler room over to a brawny Hunk at laborer's wages, put a mark on the steam gage and tell him to keep the pointer up to it.

The difference between good and poor performance on the test, the fulfilling of a guarantee, is a matter of a few hundred dollars—once and for all.

The Hunk can burn up this amount of money unnecessarily every month that the boiler is in commission.

Is it not as important to have expert intelligent work in the boiler room continually as during the brief interval of a test? Is not a continuous drain as desirable to avoid as a momentary loss?

F. W. Dean, M. E., told at a recent meeting of the American Society of Mechanical Engineers in Boston how an expert fireman saved the day in a boiler test which he was conducting by raising the evaporation per pound of combustible with the same boiler and furnace from 8.34 to 12.84 pounds. The difference in the cost of the coal which this one fireman would handle in a year and what the fireman whom he replaced would use to produce the same amount of steam at the rates given would amount to nearly five thousand dollars. Would it not be good business to make it worth his while to do it?

Five men were badly burned, one probably fatally, yesterday when a water tender on the British steamer "Pectan" connected a steam-escape pipe with a boiler in which the men were working, and before the screams of the victims reached his ears, volumes of steam had entered the boiler.

Thus reads a recent press report. In an editorial in our issue of May 26, we made the statement that marine boilers seldom have nonreturn valves. This seems to have been one of them. Why in the name of all that is humane and reasonable is the slaughter and torture of help in the steamship boiler rooms allowed to continue, when means are at hand to prevent it?

The occasion is worthy the passing of an international law requiring all steam vessels to be equipped with this protection.

A coal scoop with an edge like a frayed lace curtain is a mighty poor tool in the boiler room. Trim the edge or get a new scoop.

Correspondence

What Was Wrong?

The diagrams, Fig. 1, were taken from the same engine, a compound-tandem with cylinders 15 and 26 by 48 in., running at 80 r.p.m., with a boiler pressure of 100 lb. per sq.in., about 200 deg. F. superheat and 25 in. of vacuum. No change in the valve setting was made between taking cards Nos. 1 to 4, and 5 and 6, the load being about equal on both occasions.

The high-pressure cylinder is fitted with its valves in two parts—i.e., one on each end of the cylinder—the quick cutoff valve being fitted to the back of the main valve and simply having a vertical movement, while the main valve has an unaltering travel. The low-pressure valve is the ordinary two-ported D-valve.

The trouble was caused by the lap plates at the back-end valve having broken off, as indicated in Fig. 2. The pieces were found in the low-pressure steam chest. The only remedy, of course, was a new valve.

E. Russell.

Rochdale, England.

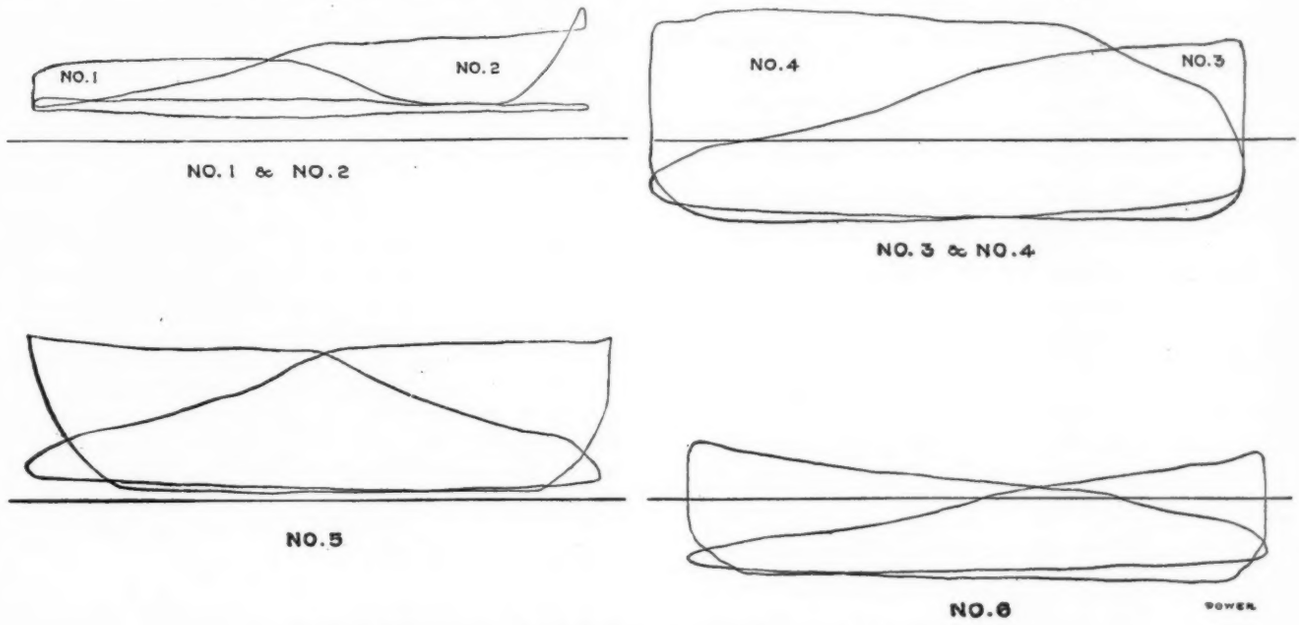


Fig. 1. Diagrams Showing Effect of Broken Cover Plate

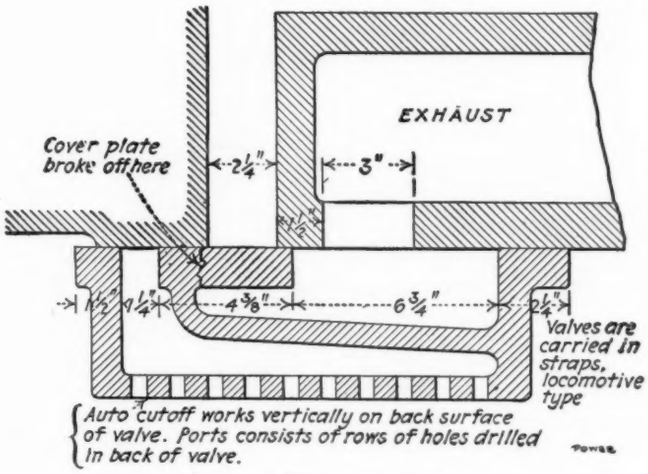


Fig. 2. Type of Valve

A Steam Pump as an Air Compressor

The use of a steam pump as an emergency air compressor, which Mr. Hudson tells about in Power of May 19, page 715, is an interesting story, but it seems to have been a waste of more or less ingenuity. Two air-tight tanks were used, and the steam pump would fill these alternately, the water compressing and expelling the air and driving it into the air receiver. It is not at all clear why the pump could not have been used to force the air directly into the receiver without all the paraphernalia of pipes, tanks, check valves, three-way valves, etc. Of course, either arrangement would waste a lot of power, but with that we have nothing to do, so long as the pump would actually work.

Now suppose that the quantity of water in the system was such that when one tank was entirely filled with water—as it should be, to expel all the air then compressed—and the other tank was entirely empty. Then if the pump kept on running it would simply pump air instead of water into the receiver; this might then be kept up indefinitely. It is likely this did occur at some time when the reversing of the three-way valves was delayed or forgotten.

This reminds me of a case of a boiler-feed pump that

handled both air and water all the time. It was in the shop of George W. Richardson, the inventor of the pop-safety valve, nearly forty years ago.

The boiler was fed by a plunger pump (connected to the engine) of more than double the capacity required. The open end of the suction extended into a cup or small bowl, and into this bowl water fell steadily from a faucet. This flow regulated the boiler feed, and the faucet was often set so nicely as to require no change for half a day at a time. As the pump had a capacity considerably greater than the boiler requirements, it would at each stroke take up all the water then in the bowl and during the rest of the stroke it took in air, which went into the boiler with the water. Richardson used to say that the air facilitated the generation of steam and was good for the boiler generally, which may or may not be accepted at the present time.

FRANK RICHARDS.

New York City.

Sluggish Constant-Current Transformer

The accompanying sketch illustrates the connections of a 5.5-ampere, constant-current transformer applied to a series incandescent street-lighting circuit. The primary coil receives constant voltage and the secondary or movable coil maintains approximately constant current through the lamps in series with it. The movable coil weighs more than the counterweight and it tends to gravitate toward the stationary coil; unless both coils are

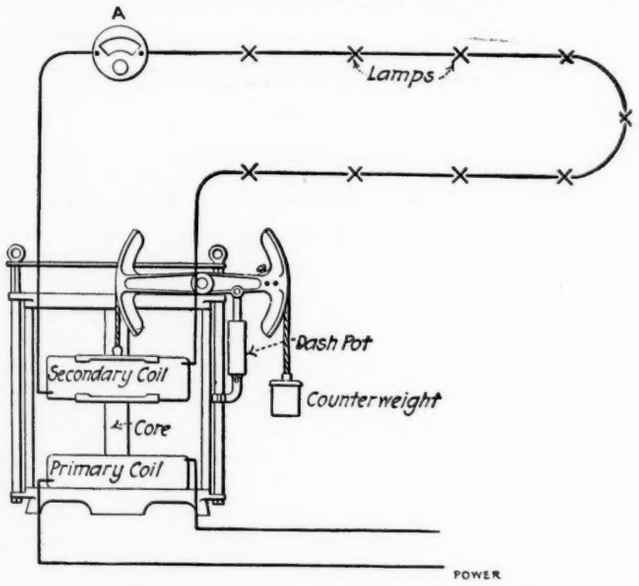


DIAGRAM OF ARC CIRCUIT AND CONSTANT-CURRENT TRANSFORMER

energized it will come to rest at the bottom of its travel.

If the coils are energized, however, a repelling force exists between them and the position taken by the movable coil will depend upon the adjustment of the transformer, upon the voltage applied to the primary and upon the current in the secondary. Assuming the secondary current and primary voltage to be such that the movable coil is in a given position corresponding to the correct value of secondary current; if the secondary current or the primary voltage decreases, the repelling force between the coils becomes less and the excess weight of the movable coil will cause it to move downward until the secondary current is restored to its former value. If the secondary current increases or the primary voltage increases, either variation tends to increase the flux through the secondary, the resulting increase in the repelling force between the coils will overcome the excess weight of the movable coil and will cause it to move upward until the secondary current is restored to its adjustment value. An operator complained that a transformer was sluggish in action and that too much of a change in the primary voltage or in the secondary current was required to cause the movable coil to respond. The inspector found this to be true, and with the movable coil in any certain position if it were moved an inch in either direction, it would remain there, a corresponding change in the secondary current being maintained. He also noted that the movable coil was rubbing against the iron core, which caused friction, and upon leveling the transformer its action was much improved. The inspector then oiled the two rocker-arm bearings, removed the dashpot, poured out the old oil, flushed it with gasoline, renewed the oil and reinstalled the dashpot. After this cleaning the action was as good as could be expected on a machine that has ordinary sleeve bearings instead of knife-edges or ball bearings.

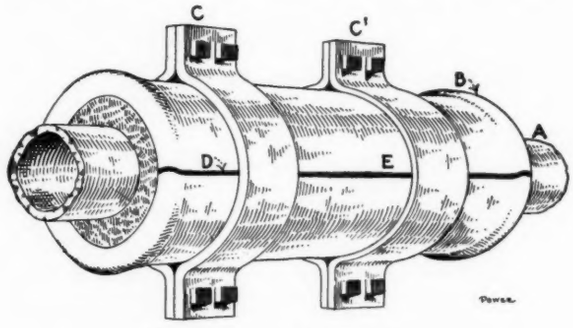
As in the case of a steam-engine governor, where a change in speed must take place before the governor can act, so in the case of a constant-current transformer—the secondary current must show temporary variations, because such variations are necessary to actuate the automatic feature of the device.

J. C. HORTON.

Schenectady, N. Y.

An Underground Pipe Repair

An 8-in., cast-iron water main under 70 lb. pressure leaked at several places. Numerous small holes within a distance of a few inches showed at each place, probably



CAST-IRON PIPE CLAMP

caused by the defective casting. The problem was how to make repairs without shutting off the water. Several factories, busy day and night, would have to close down if the water was shut off. A cast-iron pipe sleeve was split in two lengthwise, as shown at *D*, and center-punch marks were made at *E* to make sure of getting the sleeve together properly.

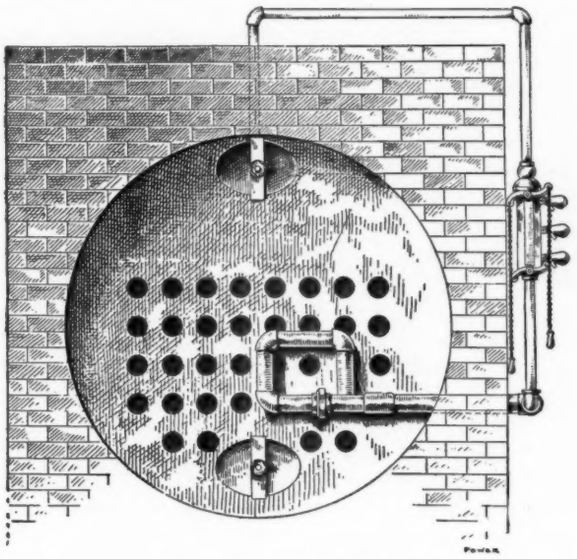
Two heavy clamps *C* and *C'* were used. Split sleeves were clamped over the defective places with strips of sheet packing ⅛ in. thick and ¾ in. wide between the two parts of the sleeve shown at *D*, shredded lead or lead

wool was used and the sleeve calked up in the usual way. This is a job where the shredded lead shines, as a joint can be made up with water escaping at the start. These joints have been in use several years and have never given any trouble.

Toronto, Ont., Canada. JAMES E. NOBLE.

A Dangerous Water-Column Connection

The nipple in the boiler head which served as the lower connection to the water column showed distress. The horizontal pipe was so rigidly set in the brickwork



TEMPORARY CONNECTION

that a new nipple could not be substituted and the pipe connected as before without considerable work and delay. The demand for the boiler was so urgent that a connection was made, as illustrated.

This, however, presented so much pipe surface to the action of the hot gases that the water level, as shown by the glass gage, was so erratic that the boiler had to be taken off the line again and a direct connection made. The capers of the water for the short time the boiler was on caused anxiety not soon to be forgotten.

Philadelphia, Penn. EDWARD T. BINNS.

Low Power Factor

An engineer who was in the habit of noticing things, observed that the switchboard output as recorded on the watt-hour meter corresponded closely with what he knew that his engines were doing; but he could not understand why his generators were overheating when the total recorded output was nowhere near their combined full-load ratings. He further determined that the total of his ammeter readings multiplied by the voltage and by any chosen number of hours, gave a result exceeding by 40 per cent. the absorption recorded by the watt-hour meter in the same length of time.

This engineer was more of an observer than a reader and while he had dug out all the data necessary to prove a case of low power factor, he was not in a position to associate his data with that name. Accordingly, he took his troubles to the chief, from whom he learned that the company had on order two synchronous condensers for improving the power factor.

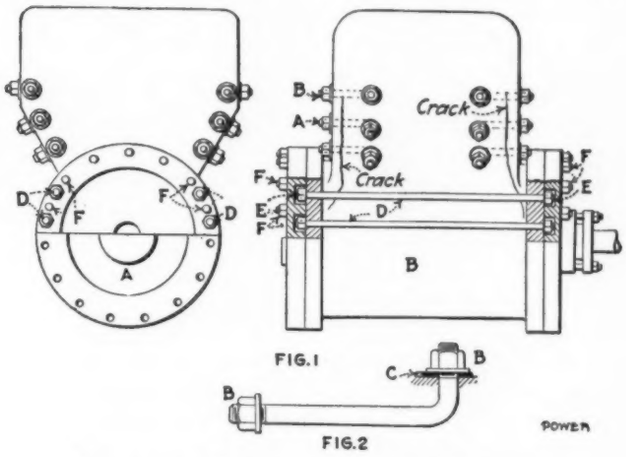
Some contend that if a man is a good observer, good thinker and a good mechanic, he does not need books nor technical papers. A man with such an idea will fall as far behind progress in his line of work as he is far behind the times in his ideas. As a matter of fact, an observing, reasoning man will get more out of judicious reading of technical papers than any other kind of man will.

Schenectady, N. Y. J. C. HORTON.

Badly Cracked Cylinder Repaired

A large vacuum pump used for water circulating and having considerable suction lift, became airbound because of a leaky stuffing-box. The piston, racing through part of the stroke and then striking a body of water, caused four 15-in. cracks, two on each side of the cylinder. Practically, the pump was completely wrecked. As we could not replace it within a month, we did an all-night repair job; the pump lasted two years longer.

The manner of repair will be seen in Fig. 1. The bolts, one of which is shown in Fig. 2, were made of ⅞-in. iron of suitable length. Holes were drilled in the pump casting and the bolts inserted from the inside, as in Fig. 1, the bolt *A* being in dotted lines. Each bolt was provided with a washer at each end, Figs. 1 and 2, under which a few turns of valve-stem packing *C*, Fig.



DETAILS OF REPAIR TO CRACKED CYLINDER

2, was placed to make the bolts water-tight. As the cracks extended down into the cylinder, the bolts *D*, Fig. 1, were also made of ⅞-in. iron and put in place outside, the nuts being set up against the face of the flange to which the cylinder covers are bolted. To provide room for these nuts, the recesses *E* were made with a flat-point drill in the inner face of the cylinder covers. These recesses were so spaced as to come between the cover studs, shown at *F*, Fig. 1.

As the nuts on the bolts *D* were entirely surrounded by the packed joint of the cylinder covers, no packing was needed beneath them. Before setting up the bolts, some iron cement was stuffed into the cracks from the inside and outside; all the bolts were then drawn up and a water-tight job was had.

Kailua, Kona, Hawaii. H. K. SCHOLEFELD.

Hocking Valley Slack Coal

The chart given with the article by Morgan B. Smith in POWER, May 26, 1914, page 740, would be very misleading according to the way we find Hocking Valley slack. Take the Geological Survey of Ohio, Fourth Series, Bulletin No. 9, by Lord and Somermeier, page 291:

	Per Cent. Ash	B.t.u. Bulletin	B.t.u. Chart
First test	17.41	10,700+	11,600
Second test	15.28	11,100	12,000
Third test	9.94	12,000	12,800
Page 292:			
First test	8.79	12,200	13,000+
Average of nine tests	7.87	12,550	13,250
Page 295:			
Average of 65 tests	7.36	12,564	12,900

From our experience, and we burn about 300 tons of Hocking Valley slack per day, as well as these tests quoted, your chart gives on an average of 740 B.t.u. high and on many tests would indicate our coal as 1000 B.t.u. higher than it is.

E. R. ANDRIX.

Columbus, Ohio.

Leaky Cylinder Joint

In regard to J. Stewart's method of stopping a leaky joint on the front end of a cylinder, as described on page 603, Apr. 28, I think he could have managed it easier and made a more solid job had he drilled a hole in the frame at an angle so that it would strike the cylinder-face joint just outside of the stud-pitch line. This hole should be about half an inch gas size, tapped to a considerable depth, and then filled with a mixture of Smooth-On cement having the consistency of thick cream. Screwing in a plug would have forced the Smooth-On into the spaces where the leakage occurred.

On an engine of the size mentioned, it would probably have been necessary to drill several such holes, but the final results would have been better, and no unsightly clamps would have been seen on a new engine.

E. R. PEARCE.

Rochdale, England.

Machinist Engineers

An engineer applied for a position, and, although he had first-class references to show that he was a reliable man, with 20 years' practical experience in large and small plants, he was turned down because he was not a practical machinist. He even offered to work on trial on condition that he should receive no pay if he did not make good. He was told that a man who had not served his time as a machinist could not be a high-class engineer.

I do not agree with this statement. It is certain that many men who are handling our large steam plants successfully are men who have worked up from small plants, and they are able to maintain their positions by study and experience, and not through a knowledge of the machinist's trade. In reality, there is but little work around the average plant that requires a thorough knowledge of the machinist's trade.

Not many plants run a machine shop in connection with the plant, so even if an engineer were a machinist his skill would be of little use in the average power plant.

Hundreds of engineers can take an engine or other machine apart and reassemble it as accurately as could a machinist. A machinist might have a more direct way of doing certain work, he may know many ways of doing things not known to the engineer, but such work is not the engineer's chief occupation. If required to do this work frequently, he will soon acquire a skill equal to a machinist's. It is all right to be a machinist, but this trade is not necessary to become a high-class stationary engineer.

JOHN THORN.

Toronto, Ont., Can.

The Foot of the Ladder

The frontispiece in the issue of June 2 appeals strongly to me.

Some years ago, just after completing a technical course, I felt the need of supplementing my technical training with a course in commercial shop practice, and so I put in many hard hours building small engines, and, later on, working in a boiler room to learn the handling of a fire.

The experience that I gained in this way has been of great value, and I strongly recommend that all young college graduates from technical courses supplement their college training by experience gained in the boiler and engine rooms of power plants.

I have on my engineering staff at this time a young man but recently out of college, and he is now working as a fireman in a boiler room to gain the practical experience, which, in my opinion, is essential to a man who wishes to round out to full measure his knowledge of power-plant operation. I wish there were more like him, but unfortunately too many college men are content to lean over a drafting board and gain purely office experience rather than soil their hands at the work of a so called practical man.

The cartoons published in POWER each week are always interesting and instructive, and I hope they will furnish an inspiration to many men in the field in which POWER is preëminent.

GEORGE W. MARTIN,
Vice-President, The New York Service Co.
New York City.

One Cause of Flywheel Explosions

In a paper mill of 2000 hp., one of the engines was a cross-compound Corliss 16x32x42-in., operating at 100 r.p.m., having a single-arm flywheel 16 ft. in diameter. Passing this flywheel on one of my trips, I noticed that the rim was vibrating very rapidly. This vibration was not in step with the engine stroke as might be thought, but was actually a quiver, showing that the spokes were springing to the amount of about three-quarters of an inch. The last thing a paper-mill engineer does or thinks of is shutting down, so I tightened both main bearings to a snug running position, which stopped the vibration. I have no doubt that the flywheel would have been wrecked if I had not discovered it soon. I think that loose bearings are responsible for a great many flywheel explosions, especially on double engines..

E. P. SHIRES.

Leominster, Mass.

Inquiries of General Interest

Overtravel—What is meant by the overtravel of a valve?

J. M.

Overtravel occurs when a slide valve of an engine not only opens the port fully but travels by, and is the amount which the outside edge of the valve passes by the inside edge of the port.

Setting of Fusible Plug in Horizontal Return-Tubular Boiler—How should a fusible plug be set in a horizontal return-tubular boiler?

J. P.

A fusible plug should be set in the rear head and so placed that its center will be not less than 2 in. above the upper surface, of any of the tubes when the boiler is set, and the plug should project 1 in. inside of the boiler.

Coal per Horsepower-Hour—What is meant by "coal per horsepower hour"?

G. B.

The average number of horsepower developed during a stated period multiplied by the number of hours of that period would be the number of horsepower-hours, and dividing the number of pounds of coal required during the same period by the number of horsepower-hours would give the pounds of coal per horsepower-hour.

Operation of Throttling Governor—Does a throttling governor change the pressure of steam in the steam chest of an engine or does the steam-chest pressure remain the same?

A. T. A.

The office of a throttling governor is to admit only enough steam to the steam chest to keep the pressure up to that necessary to maintain the speed, and the steam delivered from the boiler to the governor is thereby reduced to a different pressure in the steam chest for each different load.

Sign Meaning "Greater" or "Less Than"—What is the meaning of the signs $>$ or $<$ when placed between two quantities?

C. B. H.

The sign $>$ is to be read "is greater than" and the sign $<$ is to be read "is less than"; for instance, $6 > 5$ is read "6 is greater than 5"; and $5 < 6$ is read "5 is less than 6," the opening of the angle always being placed toward the larger quantity.

Quality of Steam—What is meant by steam of 95 per cent. quality?

E. P.

The quality or dryness of steam is the portion or per cent. of its total weight which is in the form of vapor, as distinguished from that portion of the total weight which is in the form of moisture. Hence, when the quality or dryness is 95 per cent., that per cent. of its weight is in the form of vapor, and there is present $100 - 95 = 5$ per cent. of water, i.e., the wetness is 5 per cent.

Increase of Hydrant Discharge for Increase of Pressure—When the pressure in a water pipe line is maintained at 60 lb. per sq.in. at the pumping station, the pressure at a hydrant with the valve wide open is 16 lb. per sq.in. and the discharge is about 700 gal. per min. What hydrant pressure and rate of discharge would be obtained by raising the line pressure at the pumping station to 100 lb. per sq.in.?

K. W. A.

The loss of pressure from friction in the pipe line and also the pressure at the hydrant would vary, practically as the square of the velocity or rate of discharge, and as they would continue in the same proportion, then with a total pressure of 100 in place of 60 lb. per sq.in., the hydrant pressure would become $^{16}/_{60}$ of 100 or 26.66 lb. per sq.in. The velocity or rate of discharge would vary as the square root of the hydrant pressure, but as the hydrant pressure would vary as the total pressure and a discharge of 700 gal. per min. is obtained with a total pressure of 60 lb., then with 100 lb. total pressure the discharge would be

$$700 \times \sqrt{\frac{100}{60}} = 903 \text{ gal. per min. (approximately).}$$

Use of Radius Instead of Diameter in Boiler Formula—In figuring the strength of a boiler why is "radius times 2" used in the formula in place of "diameter"?

G. H. M.

Taking pressure and stress in pounds and all dimensions in inches, the complete expression for bursting pressure of the solid part of the sheet would be:

$$\frac{\text{Thickness of plate} \times \text{length of shell} \times \text{tensile strength per sq.in.} \times 2}{(\text{Radius} \times 2) \times \text{length of shell.}}$$

By canceling "length" and dividing the numerator and denominator by 2 the expression is reduced to the simpler form:

$$\frac{\text{Thickness} \times \text{tensile strength}}{\text{radius}},$$

or expressed algebraically,

the bursting pressure $p = \dfrac{t \times S}{r}$

Size of Line Wires—Six hundred 16-cp. lamps on a three-wire system are operated at a distance of ¼ mile from the station. If the allowable drop is 5 volts on each side of the system, what should be the size of the outside wires if the neutral is one-half the size of the outside wires?

A. W. C.

Assuming that the system is balanced, with 300 lamps on a side and each lamp taking ½ amp., the total load on each outside wire would be 150 amp. Counting both sides the total drop being 10 volts and length of the line 1320 ft., the problem may be solved by the formula:

$$A = 22 \times I \times L \div E,$$

and if

A = Area of conductor in circular mills;
I = Current in amperes;
L = Length of circuit, one way;
E = Total drop in volts.

Then,

$$A = 22 \times 150 \times 1320 \div 10 = 435{,}600.$$

A 400,000-circ. mil cable would probably answer for the outside wires and a 200,000-circ. mil cable for the inside wire.

Flow of Steam Through Orifice—What would be the increase in the flow of steam through an orifice into a vacuum of 14 in. over that taking place into a vacuum of 8 in., the pressure at the entrance side of the orifice in each case being 5 lb. per sq.in. gage pressure?

J. H.

The flow of steam of a greater pressure into an atmosphere of a less pressure increases as the difference of prssure is increased until the lower pressure becomes only 58 per cent. of the greater absolute pressure, but the flow is neither increased nor diminished with any greater reduction of the lower pressure. The pressure at the entrance side of the orifice being

$$5 + 14.7 = 19.7 \text{ lb. per sq.in. absolute,}$$

then when the orifice discharged into an atmosphere at 14 in. vacuum or

$$(30 - 14) \times 0.491 = 7.856 \text{ lb. per sq.in. absolute,}$$

the lower pressure would be

$$\frac{7.856}{19.7}$$

or about 40 per cent. of the higher; and discharging into 8 in. vacuum the lower would be

$$(30 - 8) \times 0.491 = 10.802 \text{ lb. absolute,}$$

or about 55 per cent. of the higher. Hence as in each instance the discharge would take place into an atmosphere of a less pressure than 58 per cent. of the absolute pressure on the entrance side of the orifice, there would be no increase in the amount of steam flowing into a 14-in. vacuum over that which would flow into an 8-in. vacuum.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for inquiries to receive attention.—EDITOR.]

Engineers' Study Course

Elementary Mechanics--XV

LAST LESSON'S ANSWERS

61. The force of friction will equal

$$200 \times 0.28 = 56 \text{ lb.}$$

which will be the force that will keep the casting moving at a uniform rate. The force required to move the casting will be greater depending upon the time it takes to get the casting in motion.

62. The force required to raise the body from the ground is greater than that necessary to move the body along the ground. The force of friction is the only force to be overcome in moving the body along the ground, while to lift the body the force of gravity (or the weight of the body) must be overcome. Generally the force of friction will be less than the weight of the body.

63. The coefficient of friction is equal to the tangent of the angle a which in this problem is 15 deg. Hence the value of f is

$$\tan 15 \text{ deg.} = 0.268$$

64. The coefficient of friction

$$f = \frac{\text{the force of friction}}{\text{the total normal pressure}}$$

In this problem the friction is assumed as 600 lb. Therefore,

$$f = \frac{600}{60{,}000} = 0.01$$

65. The tangent of the angle a made by the plane will equal the coefficient of friction. Thus

$$f = \tan a, \text{ hence } \tan a = 0.3$$

From a table of tangents the value of a is found to be 16 deg. 40 min.

FRICTION (CONTINUED)

Friction is encountered in every type of machine or apparatus used in the power plant. The aim of the engineer is to reduce it to a minimum by using bearing metals and lubricants having a low coefficient of friction, combined with other equally important conditions. The introduction of ball and roller bearings has reduced this coefficient of friction from 0.04 for the ordinary steel journal running in a brass bearing, to 0.003 for the better forms of roller bearings.

The following laws of friction were stated by Morin and Coulomb as a result of a series of experiments.

I. *The friction depends on the nature of the surfaces in contact, but is independent of the area in contact.*

II. *The friction varies directly as the normal pressure, assuming the materials of the surfaces in contact to remain the same.*

III. *The friction is independent of the velocity when there is sliding motion.*

Recent experiments have proved that these laws are not absolutely true, more especially in the case of law III, where it has been found that the *friction decreases when the velocity increases.* Also, as stated in last week's lesson, the force of friction when a body is just about to move, is greater than when the body is in motion. The subject of friction will be discussed more fully under the lessons relating to work and efficiency.

This closes the work on Statics which has had to do with forces that produced a state of equilibrium of a given body. The following lessons will deal largely with *forces that do not produce equilibrium,* but which tend to produce motion of various kinds; and also with forces that perform work in a more or less efficient manner.

PART II—KINETICS

MOTION

A body is said to be in *motion relative to another when its position changes with respect to that of the other body*; or as sometimes defined, *motion* is *simply displacement* or *change of position.* At the outset it is well to note that, in the strictest sense of the word, all motion is *relative,* and the term *absolute motion* is apt to be misleading. Take for illustration a train passing a certain station at a definite rate of motion, say 30 miles per hour. It is not fair to say that the *absolute motion* of the train is 30 miles per hour, for while that is the motion of the train relative to the station, it is also true that the station has a definite velocity relative to the center of the earth which in turn has its velocity relative to some point in the universe. As another example, consider the motion of the crosshead of a locomotive. Here the crosshead has a motion relative to the frame of the engine, it has still another motion relative to the crankpin, a different motion relative to the track, and an entirely different motion relative to some fixed point in the universe. To avoid confusion it is best to compare the motions of various bodies to some point which for all practical purposes may be assumed as fixed. Thus to compare the motions of the crankpin and of the crosshead of the locomotive both might be referred to the frame of the engine. In the problems which are to follow the earth will be considered as the fixed point of reference.

As stated in Lesson VI, April 28, motion may be divided into two general classes: (1) *Translation* and (2) *Rotation.* In the case of translation all points of the given body will move in straight lines at the same rate of motion. In rotation, all points of the body will move in such a manner as to remain at a fixed distance from a given center of rotation.

Speed is the rate of motion of a body, or the rate at which the body describes its path. An automobile may be capable of developing a speed of 60 miles per hour and at the end of 2 hours be 120 miles from its starting point. The direction the machine went has nothing to do with its speed and hence the term speed involves only the two items of *magnitude* and *time,* without any reference being made to the *direction* of the motion. The speed of a body then is not sufficient to definitely fix the motion of the body.

Velocity is the rate of displacement of a body, and re-

quires not only *magnitude* and *time* but also *direction.* The velocity of a body completely specifies the motion of the body, as to direction, magnitude and time. To say that a body has a velocity of 50 ft. per sec. means that if the body were to move for one second at a uniform rate it would pass over 50 ft. of space. The velocity might change before the completion of the second and therefore the velocity of a body indicates the speed or rate of displacement *for a given instant only,* without any prediction as to what may be expected the next instant. The velocity of the body may be uniform or variable; hence motion may again be classified as *uniform* or *variable* depending upon whether or not the body covers the same amount of space for every second it is in motion.

The common unit for space is the *foot,* the unit for time is the *second* and the unit for velocity is the number of *feet per second.* Unless otherwise stated, these units will be used in the formulas that follow in the succeeding lessons.

The velocity of a rotating point may be expressed in *linear units,* that is, feet per second, or in *angular measure,* that is, in *revolutions per minute,* or *radians per minute.*

Example—The distance from the center of the crankshaft to the center of the crankpin of a steam engine is 6 in. If at a given instant the engine is running at 300 r.p.m., what is the velocity of the crankpin?

Solution—This problem as stated is capable of two interpretations, depending upon what velocity is desired. It is evident that all points in the crank are making 300 r.p.m. Each time the engine makes one revolution the crank passes through 360 deg., or through 2π radians. (Note—*the angle at the center of a circle which intercepts an arc on the circumference equal to the length of the radius of the circle is called a radian.*) The circumference of a circle is $2\pi R$, where $\pi = 3.1416+$; hence there are $\frac{2\pi R}{R} = 2\pi$ radians in the circumference. Therefore a

$$radian = \frac{360\ deg.}{2\pi} = 57.3\ deg.\ (approx.)$$

Since the engine is making 300 r.p.m., the crank will pass through

$$300 \times 2\pi = 600\pi\ radians$$

This is known as the angular velocity of the crankpin. The second interpretation of the problem is to find the linear velocity of the crankpin, or the velocity with which the crankpin would move off in a straight line if, at any instant, the pin were suddenly released from the crank. The linear velocity will depend upon the distance of the pin from the center of the shaft. In one revolution the crankpin passes over a distance equal to the circumference of a circle whose radius is 6 in., and in one minute the crankpin moves over a distance equal to

$$\frac{2\pi \times 6 \times 300}{12} = 942\ ft.$$

Hence the linear velocity of the crankpin is 942 ft. per min., and the angular velocity is 600π radians per min.

The angular velocity of a body is equal to the linear velocity divided by the radius of rotation.

Let

R = The radius of rotation of the given body in feet;

N = Revolutions per minute (r.p.m.);

V = Linear velocity in ft. per min.;

a = Angular velocity in radians per min.

Then

$$V = 2\pi \times R \times N \qquad (24)$$

and

$$a = 2\pi \times N \qquad (25)$$

hence

$$\frac{a}{V} = \frac{2\pi \times N}{2\pi \times R \times N} \text{ or } a = \frac{V}{R} \qquad (26)$$

The space S, traversed by a body moving with a uniform velocity of V ft. per sec. for a total time of T sec., is equal to $V \times T$ ft., or expressed as an equation

$$S = V \times T \qquad (27)$$

STUDY QUESTIONS

66. At what crank angle is the friction between the crosshead and guide of an engine the greatest?

67. What kind of motion has the crosshead of an engine, (b) the crankpin, (c) a point on the rim of the flywheel.

68. The stroke of an engine is 18 in. If the engine makes 250 r.p.m., what is the average speed of the piston in ft. per min.?

69. Is the velocity of the crosshead of an engine uniform or variable? Should the velocity of the crankpin be uniform or variable? State reason for your answer.

70. A fireman walks at the rate of 4 miles per hour. How long will it take him to pass through a boiler room which is 250 ft. long, assuming that he walks in a straight line?

Salt Softens Clinker on Sidewalls

Clinker adhering to the sides of the furnace walls and tending to bridge over the grate is an annoying trouble in many plants. Sometimes the clinker is knocked off with a firing tool, and in this way much damage is done to the brickwork.

In one Canadian plant serving a salt works, chain-grate stokers are used and considerable trouble was caused by clinker adhering to the side walls and extending out over the grate. The clinker was removed in the manner mentioned.

Much of the very low-grade salt is thrown away at these works. One day last winter the laborers conceived the idea of dumping some of the waste salt into the coal pile in front of the boilers instead of wheeling it a long distance in the cold. Soon after using this "salted coal" it was noticed that the clinker on the side walls had vanished; investigation and experiment showed that the salt was responsible for its disappearance. Now, when it is desired to remove clinker on the side walls a few shovelfuls of salt are thrown into the coal hopper feeding the stoker and a little is also thrown on the clinker.

New Anthracite Coal Field—An anthracite coal field has recently been discovered in the Province of British Columbia, Canada, within two miles of the G. T. P. Railway main line. Several seams have been located, one apparently 40 feet wide. An analysis of the outcroppings show: Carbon, 80.93 per cent.; volatile matter, 7.07 per cent.; moisture, 4.02 per cent.; ash, 7.98 per cent.; specific gravity, 1.661. The coal makes a strong and lasting fire, free from clinker. The development of this field will mean much to the Pacific Coast.

Boiler Explosions During 1913

Date	Place	Plant	Time of Day	Kind of Boiler	Pressure Carried, Lb.	Size	Killed	Injured	Property Loss	Probable Cause
Jan. 1	Portland, Me.	E. T. Burrows Co.					0	0		Furnace mouthpiece exploded
Jan. 1	Dover, Del.	Light & Water Plant					0	0		
Jan. 2	Waller, Penn.	Thomas J. Hess	7:00 p.m.	Traction engine	100	10 hp.	1	0		Safety valve failed to act
Jan. 3	Lawrenceburg, Tenn.	Lentz Sawmill	9:00 a.m.	Locomotive		25 b.hp.	1	1	$100	Old and worn out
*Jan. 4	Glen Allan, Miss.	Glen Allan Oil Mill		Water tube			0	1	$100	Low water
Jan. 5	Marshalltown, Ia.	Dr. H. C. Mueller Residence		Heating			0	0	Small	
Jan. 6	Wheeling, W. Va.	Nebraska Masonic Home					0	1		
*Jan. 6	Niagara Falls, N. Y.	Niagara Alkali Co.		Water tube	100	350 hp.	0	1	$250	Blow-off opened and forgotten
Jan. 7	Beaver Falls, Penn.	Keystone Driller Co.	5:45 p.m.	Stub tubular upright	80	12 b.hp.	1	4	$100	Weakness of shell
Jan. 7	Knoxville, Tenn.	Tivy High School		Heating			0	0		
Jan. 8	Cincinnati, Ohio	Victor Lamp Co.	4:45 p m.	Tubular	85	300 b.hp.	0	1	$50	Blow-off valve failure
Jan. 8	Coffeyville, Kan.	Kansas Oil Refining Co.		Locomotive		25 hp.	0	1	0	Fusible plug melted
Jan. 8	Schenectady, N. Y.	American Locomotive Co.					0	1		
Jan. 9	Little Rock, Ark	Marion Hotel	8:45 a.m.	Water tube	100	150 b.hp.	0	0	0	Cast-iron header failed
†Jan. 9	Toledo, Ohio	Office Building of Spitzer Bldg. Co.					0	1		
Jan. 9	Salt Lake City, Utah	Salt Lake Tribune	1:30 p.m.	Water tube	120	235 hp.	0	0	$142.30	Low water
Jan. 9	Rochester, N. Y.	Payne's Garage	p.m.	Vertical tubular			0	3	$50	Failure of feed supply
Jan. 9	Hephzibah, Ga.	T. E. Smith's Sawmill	4:00 p.m.	Tubular		20 b.hp.	1	1	$300	Cold water injected into hot boiler
Jan. 10	Brinkhaven, Ohio	Sawmill					1	0		
Jan. 10	Valley City, N. D.	Electric Light & Water Works					0	0		
*Jan. 10	Ensley, Ala.	Semet-Solvay Co.		Water tube	125	250 b.hp.	0	0	$6	Defective material
*Jan. 10	Indiana Harbor, Ind.	Inland Steel Co.		Water tube			0	0		
*Jan. 10	Columbus, Ohio	State Institution for the Blind		Water tube			0	1		
Jan. 10	South Boston, Mass.	Hunt Spiller Mfg. Corp.		Cast-iron sectional heating			0	0		
*Jan. 11	Richard City, Tenn.	Dixie Portland Cement Co.		Water tube			0	1		
Jan. 11	Grasselli, Ind.	Grasselli Chemical Co.		Water tube			0	0		
*Jan. 11	Philadelphia, Penn.	John B. Stetson Co.		Water tube			0	0		
Jan. 11	Minneapolis, Minn.	North Side Greenhouse					0	1		
Jan. 12	Lebanon, Penn.	Lebanon Valley Iron & Steel Co.	10:00 a.m.	Horiz. tubular	70	125 b.hp.	0	5	$750	Low water
*Jan. 12	Chicago, Ill.	United States Brewing Co.		Water tube			1	0		
Jan. 13	Burlington, Vt.	City of Burlington		Cast-iron sectional	15		0	0	$317	
Jan. 13	Pine Barren, Fla.	McMillan Lumber Co.	5:30 p.m.	Horiz. return tubular	100	72x16	1	4	$5000	Low water
Jan. 14	Vidalia, La.	School		Heating			0	0	approx.	
Jan. 14	Toledo, Ohio	Buckeye Clay Pot Co.					0	0		
Jan. 15	New York, N. Y.	860 Westchester Ave.					0	1		
Jan. 15	New York City (Bronx)	Jos. Harper's Dry Goods Store		Heating			0	1		
Jan. 16	Boonville, Miss.	Lumber Camp Sawmill					1	4		
Jan. 17	Leavenworth, Kan.	Home-Riverside Mine					0	0		
Jan. 17	Wooster, O.	University of Wooster	7:00 a.m.	Water tube	110	150 hp.	0	0	$300 to $400	Low water, feed line stopped
Jan. 18	Liberty Centre, Ohio	Moving Picture Theatre					0	0		
*Jan. 18	Philadelphia, Penn.	Miller Lock Co.		Water-tube			0	0		
*Jan. 18	Connellsville, Penn.	Am. Water Wks. & Guarantee Co.		Water tube			0	1		
Jan. 19	Plattsmouth, Neb.	Masonic Home	10:00 a.m.	Cast-iron heating	25	8 sections	0	1	$600	Defective casting
Jan. 20	Howland, Me.	Howland Pulp & Paper Co.	8:30 a.m.	Return tubular	80	72″x19′ 6″	2	3	$40,000	Unknown
Jan. 21	Luzerne, N. Y.	Burt Shirt Co. Factory	6:30 p.m.	Hot water			0	1	$25	Explosion of coal gas in flue
*Jan. 21	Willimantic, Conn.	Turner Silk Co.		Water tube	125	150 hp.	0	0		Feed pipe failed. Low water
*Jan. 23	Pittsburgh, Penn.	Carnegie Steel Co.		Water-tube			0	1		
*Jan. 23	Pittsburgh, Pa.	Pittsburgh Term. Warehouse Co.		Water-tube	125		0	0	$80	
Jan. 24	Macon, Ga.	Atlanta Mng. & Clay Co.		Horizontal-tubular	95		0	0	$150	
Jan. 24	Bradford, Penn.	Newell Estate Oil Lease					0	1		
*Jan. 25	Waukegan, Ill.	American Steel & Wire Co.		Water tube			0	0		
*Jan. 28	Mitchell, Ind.	Lehigh Portland Cement Co.	10:00 a.m.	Water tube	150		0	0	slight	
Jan. 28	Brandon, Vt.	Newton-Thompson Mfg. Co.		Horizontal-tubular			0	0	450	
Jan. 29	Chattanooga, Tenn.	Y. M. C. A.		Cast-iron sectional	15		0	0	91	
Jan. 29	Indianapolis, Ind.	Alice Cathcart		Cast-iron sectional	15		0	0	$140	
Jan. 29	Cleveland, Ohio	Upson Bolt & Nut Co.					0	4		
Jan. 30	Marshalltown, Ia.	Traction engine					1	0		
*Jan. 31	Troy, N. Y.	Allen & Wheeler Co.					0	2		
*Jan. 31	Glen Allan, Miss	Glen Allan Oil Mills		Water tube	125		0	0	$150	Low water
†Feb. 1	Paris, Ill.	T. A. Foley Sawmill					0	1		
Feb. 4	Worcester, Mass.	Elizabeth School		Cast-iron heating			0	0		
Feb. 4	Garden City, La.	Albert Hansen Lumber Co.		Tubular	150	72″x18′	0	0	0	Unknown
Feb. 4	Bath, S. C.	Aiken Mfg. Co. Cotton Mill					0	0		
Feb. 5	Portland, Ind.	Traction Engine					0	0		
Feb. 5	Brookfield, Cook Co., Ill.	Lincoln & Maple Ave. School					0	0		
Feb. 5	Boston, Mass.	Pittsburg Plate Glass Co.		Cast-iron heating			0	0		
Feb. 5	Piedmont, Ala.	Sawmill	1:00 p.m.	Locomotive		25 b.hp.	1	1	$500	Low water
Feb. 6	Rusk, Tex.	Richey's Sawmill					2	5	Considerable	
†Feb. 6	Buhl, Minn.	Fort Henry Mining Co.	11:30 a.m.	Return-tubular	150	72″x18′	0	0	$96.25	
*Feb. 6	Chicago, Ill.	Congress Hotel		Water-tube			0	0		
Feb. 6	New York City	Isaac Guggenheim		Horizontal-tubular	80		0	0	$50	
Feb. 7	San Francisco	Consumers Ice Co.		Water-tube			0	0	$600	
*Feb. 7	New Orleans, La.	New Orleans Ry. & Lt. Co.		Water-tube			0	0		
*Feb. 7	Waterbury, Conn.	Scoville Mfg. Co.	10:00 a.m.	Water-tube	125	400 hp.	0	1	Tube	
Feb. 8	Louisville, Ky.	C. A. Roberts		Cast-iron sectional	15		0	0	$125	

*Tube failure. †Blowoff failure.

BOILER EXPLOSIONS DURING 1913—Continued

Date	Place	Plant	Time of Day	Kind of Boiler	Pressure Carried, Lb.	Size	Killed	Injured	Property Loss	Probable Cause
Feb. 8	East Providence, R. I.	245 Broad St.					0	0		
†Feb. 9	Williamsburg, Penn.	West Virginia Pulp & Paper Co.					0	0		
Feb. 9	Hale, Mich.	Salisbury Shingle Mill		Upright-tubular	95		0	32	$500	
Feb. 10	Baltimore, Md.	Apt'm't House, 2117 Guilford Av.	10:20 a.m.	Cast iron, steam, vapor		450 sq.ft.	0	0	Exp. $15	Unknown
Feb. 11	Fort Kennedy, Penn.	Ehret Magnesia Covering Co.		Water-tube			0	0	Fire $450	
Feb. 12	Menominee, Mich.	White Cedar Mill					0	2	$500	
*Feb. 12	Columbia, S. C.	Columbia Ry., Gas & Electric Co.		Water-tube			0	0		
Feb. 12	West New York, N. J.	Trinity Reformed Church		Cast-iron heating			0	0		
Feb. 12	Chippewa Falls, Wis.	Star Mills	8:00 a.m.	Firebox	Low	10 b.hp.	0	0	slight	Old worn out boiler. Staybolts pulled out
Feb. 13	Beechurst, L. I.	27th St. and 16th Av.					0	1		
Feb. 13	East Orange, N. J.	Edison Works					0	0		
*Feb. 13	Pittsburgh, Penn.	Allegheny Co. Light Co.		Water-tube			0	2		
Feb. 13	Portland, Me.	Maine Central R. R. Co. Wharf					0	0		
†Feb. 13	Philadelphia, Penn.	Protestant Episcopal Hospital					0	0		
†Feb. 14	Philadelphia, Penn.	Protestant Episcopal Hospital					0	0		
Feb. 14	Boston, Mass.	Snow Association, 105 Federal St.		Cast-iron heating			0	0		
Feb. 14	New York	Mark Schwartz		Cast-iron sectional	15		0	0	$150	
Feb. 15	St. Louis, Mo.	Paul Ellenberg		Cast-iron sectional	15		0	0	$90	
*Feb. 15	South Bend, Ind.	Studebaker Co., Carriage Works		Water-tube			0	0		
Feb. 15	Provo, S. D.	Locomotive					3	0		
Feb. 15	Wallisville, Mass.	C. R. Cummings Sawmill					4	5	$10,000	
Feb. 15	Newburg, Ind.	Sargent Coal Co.					0	0		
*Feb. 16	New Orleans, La.	Crescent City Stock Yards		Water-tube			0	0		
*Feb. 17	New Orleans, La.	New Orleans Ry. & Light Co.		Water-tube			0	0		
Feb. 17	New York City	Mrs. Anna Quinn		Cast-iron sectional	15		0	0	$72	
Mar. 18	New York, N. Y.	Apartment House, 113 Leonard St.		Cast-iron heating			0	0		
Mar. 18	Baywood, Fla.	Stafford Sawmill					1	1	$1500	
Feb. 19	Smithers, W. Va.	W. R. Johnson Coal Co.		Horizontal-tubular	100		0	0	$1100	
Feb. 19	Oil City, Penn.	Carnick Junk Co.					0	1		
Feb. 19	Wichita, Kan.	Bridge Pasteurized Milk Co.		Locomotive type			0	0		Crown sheet collapsed
Feb. 19	Holyoke, Mass.	Annie Shafer's Apartment House		Heating			0	0		
Feb. 19	Camden, Ark.	Cleveland School		Cast-iron heating			0	0		
Feb. 21	Denver, Colo.	Jupiter Coal Co.					0	0		
Feb. 21	Unity, Penn.	South Penn. Oil Lease					0	1		
*Feb. 22	Toledo, Ohio	Pickand Mather Co. Blast Furnace		Water-tube			0	0		
*Feb. 22	Piermont, N. Y.	Piermont Paper Co.		Water-tube			0	2		
Feb. 23	Louisville, Ky.	Monon. River Coal & Coke Co.		Horizontal-tubular	80		0	1		
Feb. 24	Brush, Col.	Brush Light & Power Co.					0	0		
Feb. 25	Providence, R. I.	H. C. Clarke Estate Coal Dealers					0	0		
*Feb. 25	Crystal City, Mo.	Pittsburg Plate Glass Co.		Vertical tubular			0	3		
Feb. 25	Iron River, Mich.	Munro Iron Mining Co.					0	0	small	
*Feb. 28	Youngstown, Ohio	Mahoning & Shenango Ry. Lt. Co.		Water-tube			0	1		
Feb. 28	Philadelphia, Penn.	Nathan Somers Hat Works		Hot-water heating			0	1		
*Mar. 1	Waukegan, Ill.	American Steel & Wire Co.		Water-tube			0	0		
*Mar. 1	Handley, Texas	Northern Texas Traction Co.		Water-tube			0	0		
Mar. 2	Honesdale, Penn.	Riefler & Sons Wood Alcohol Plant					0	1		
Mar. 3	Nyack, N. Y.	Robert Smith Confectionery Co.	9:00 a.m.	Hot-water heating	20	800 sq.ft.	0	0	$125	Frozen overflow pipe from expansion tank
Mar. 3	Alton, Ill.	Western, Cartridge Co.					0	0		
Mar. 3	Chattanooga, Tenn.	Atlantic Ice & Coal Corp.		Water-tube			0	1		
Mar. 3	Gladwater, Tex.	Gladwater Lumber Sawmill	9:17 a.m.	Horizontal tubular		60''x14'	3	2	$1500	Low water and high pressure
Mar. 4	Indiana Harbor	American Steel Foundries		Water-tube			0	0	$1000	
Mar. 4	Milwaukee, Wis.	Milwaukee Lithographing Co.	1:00 p.m.		60		0	1	nominal	Blowoff pipe broke off
Mar. 4	Grand Rapids, Mich.	Voight Milling Co.		Water-tube			0	0		
Mar. 4	Cedar Rapids, Iowa	J. S. Polland's greenhouse					0	0		
†Mar. 5	Omaha, Neb.	Omaha General Hospital					0	0		
*Mar. 5	Laurel Hill, L. I., N. Y.	Nichols Copper Co.	7:30 p.m.	Water-tube	160	240 b.hp.	0	1	trifling	Defective tube
*Mar. 5	St. Louis, Mo.	Am. Car & Foundry Co.		Water-tube			0	3		
Mar. 5	McAdoo, Penn.	Greek Catholic Rectory					0	0		
*Mar. 6	Buffalo, N. Y.	International Ry. Co.		Water-tube			0	0	$75	
Mar. 6	El Dorado, Ark.	El Dorado Light & Water Co.		Water-tube			0	0		
*Mar. 6	Etna Boro, Penn.	Carnegie St. Co.'s Isabella Furnace		Water-tube			0	0		
Mar. 7	Sharon, Penn.	Wilke's Rolling Mill	5:00 a.m.	Vertical water-tube	80	75 b.hp.	3	3	$15,000	Admitting cold water after low water
Mar. 8	Philadelphia, Penn.	J. S. Brill Co. Car Shop		Water-tube			0	1		
Mar. 10	Fordyce, Ark.	Foedyce Lumber Co.		Locomotive			0	0		
Mar. 11	Vincennes, Ind.	Meyer Bros. Sawmill	12:00 m.	Traction engine		20 b.hp.	1	3	$800	Unknown
*Mar. 11	Pittsburgh, Pa.	Crucible Steel Co. of America		Water-tube			0	0	$350	
Mar. 12	Glen Wilton, Va.	Princess Furnace Co.					0	0		
*Mar. 13	Cambridge, Ohio	Am. Sheet & Tin Plate Co.		Water-tube			0	0		
*Mar. 15	Colorado Springs, Colo.	United Gas & Elec. Corp.	7:00 a.m.	Water-tube	150	500 b.hp.	0	0	$175	Defective tube
Mar. 16	San Benito, Tex.	San Benito Land & Water Co.		Horizontal-tubular			1	0	$100	
Mar. 16	Plainville, Kan.	Plainville Mill & Elev. Co.	4:00 a.m.	Water-tube			0	1	0	Gas exploded underboiler. Oil used
Mar. 16	Atlanta, Ga.	Imperial Hotel	11:00 a.m.	Cast-iron heating	12	15 sq.ft. grate	0	0	$100	Casting cracked
Mar. 16	Florence, Neb.	Price Building	4:00 p.m.	Cast-iron heating	5-12		0	0	$500	Boiler run dry
Mar. 17	Owensboro, Ky.	B. C. Wilson's Sawmill					2	2		
†Mar. 18	Cedar Rapids, Iowa	Hotel Montrose		Return-tubular	85		0	2	slight	Stripped thread
Mar. 20	Philadelphia, Penn.	Standard Roller Bearing Co.		Water-tube			0	0		Cast-iron cross box failure
Mar. 21	Norristown, Penn.	American Equipment Co.	5:30 a.m.	Locomotive type	100	80 b.hp.	0	1	0	Low water

*Tube failure. †Blowoff failure.

BOILER EXPLOSIONS DURING 1913—Continued

Date	Place	Plant	Time of Day	Kind of Boiler	Pressure Carried, Lb.	Size	Killed	Injured	Property Loss	Probable Cause
Mar. 22	Normal, Ill.	Christian Church		Heating			0	0	slight	
Mar. 24	Chicago, Ill.	Armour & Co. Stock Yards		Water-tube			0	0		
*Mar. 24	Ashaway, R. I.	Ashaway Line & Twine Co.	5:30 a.m.	Water-tube	80		0	0	$50	
Mar. 24	Ecorse, Mich.	Worcester Salt Co.					0	0		
Mar. 24	Milwaukee, Wis.	Thomas Furnace Co.	p.m.				0	2		
*Mar. 25	Tonawanda, N. Y.	Tonawanda Board & Paper Co.		Water-tube			0	0		
Mar. 27	Salt Lake City, Utah	Irving School	7:30 a.m.	Cast-iron heating	15	S36—5	0	0	$200	Low water
†Mar. 27	Yolande, Ala.	Yolande Coal & Coke Co.					0	1		
Mar. 29	Vinita, Okla.	Middle West Utilities Co.					0	0		
Mar. 31	Toronto, Ont.	King Suspender Co.	p.m.	Cast-iron hot water			0	0	$100	Unknown
†Apr. 1	Aberdeen, S. D.	Tiffany Bros. Laundry		Tubular	100	72″x18′	0	0	$150	
Apr. 2	Houma, La.	St. Louis Cypress Co. Dredgeboat	a.m.				0	2		
*Apr. 2	Wampenn, Penn.	Crescent Portland Cement Co.	4:15 p.m.	Water-tube	150	500 hp.	0	2	small	
†Apr. 5	Bridgeport, Conn.	Spring Perch Co.					0	0	$25	
Apr. 6	Prospect Hill, Mo.	Union Sand & Material Co.		Horizontal-tube			0	1		
*Apr. 8	Pittsburgh, Penn.	Duquesne Light Co.		Water-tube			0	1		
Apr. 9	Martins Creek, Penn.	Alpha Portland Cement Co.		Water-tube			0	0		
Apr. 10	Rose Lake, Idaho	Rose Lake Lumber Co.					0	0		
Apr. 10	Philadelphia, Penn.	100 Phili-Ellena St.					0	1		
Apr. 10	Bartelsville, Okla.	Barnsdall Oil Co.		Well drilling outfit			0	1		
Apr. 10	Butler, Penn.	Tugboat					2	0		
*Apr. 10	New Orleans, La.	Crescent City Stock Yard		Water-tube			0	0		
Apr. 13	Cherry Grove, Ore.	Lovegren Lumber Co.					0	0		
Apr. 14	Sebewaing, Mich.	C. F. Bach Brewery					0	0		
*Apr. 15	Indianapolis, Ind.	Terre Haute & Eastern Trac. Co.		Water-tube			0	0		
†Apr. 16	Fort Smith, Ark.	Border City Cold Storage Co.	4:00 a.m.	Horizontal tubular	120	72″x18′	0	0	$5.00	
*Apr. 17	Seattle, Wash.	Washington Hotel Co.		Water-tube			0	0		
Apr. 19	Venice, Penn.	Venture Oil Co. Oil-well Drilling	7:00 p.m.	Oil well drilling outfit			2	2		Low water
Apr. 20	Selma, Calif.	Frank Rouch's Pumping Plant	10:00 a.m.	Traction engine	70	30 hp.	1	1	$500	Old boiler
Apr. 21	Tuna, Penn.	Oil well drilling	5:00 p.m.				0	1		
*Apr. 22	Charleston, S. C.	Charleston Ry., Lt. & Power Co.		Water-tube			0	0		
Apr. 22	Mt. Pleasant, Mich.	Thompson & Son Brickyard	10:30 a.m.	Horizontal tubular		50″x16′	4	4		Low water and old defective, patched boiler
Apr. 23	Columbia, Penn.	Frankford's Sawmill	1:20 p.m.	Horizontal tubular	175	20 b.hp.	0	2	$2000	Boiler worn out
Apr. 26	Hibbing, Mich.	Oliver Iron Mining Co.					0	0		
Apr. 28	Atlanta, Ga.	Imperial Hotel		Cast-iron heating			0	0		
*Apr. 28	Trenton, N. J.	American Bridge Co.		Water-tube			0	0		
Apr. 30	Lyman, Miss.	Ingraham-Day Lumber Co.		Locomotive			1	0		
Apr. 30	Louisville, Ky.	Sixth St. School		Cast-iron heating			0	0		This and the following were two separate accidents
Apr. 30	Louisville, Ky.	Sixth St. School		Cast-iron heating			0	0		
Apr. 30	Danville, Ky.	George Rowsey Sawmill					0	2		
May 1	Longview, Tex.	Castleberry & Flewellyn's Planer	4:00 p.m.	Return tubular		48″x16′	0	2	$3500	Deteriorated shell was very old and thin
May 2	Liberty, Mo.	Liberty Elec. Lt. & Pr. Co.					0	0		
*May 3	Kalamazoo, Mich.	King Paper Co.		Water-tube			0	0		
May 3	Pine Creek, Va.	Guthrie Sawmill	11:00 a.m.	Tubular			2	1	$400	Low water
May 4	New Salem, Penn.	Herbert Coke Works					0	2		Low water
May 5	Union Bridge, Md.	Tidewater Cement Co.		Water-tube	125		0	1		
*May 5	Kalamazoo, Mich.	City Lighting Plant	2:00 a.m.	Water-tube	140	175 hp.	0	1	$75	Defective tube
May 5	St. Johnsbury, Vt.	North Monroe Sawmill	11:00 a.m.			30 hp.	0	0	$1000	Low water
May 6	Monroe, N. H.	North Monroe Steam Mill Co.					0	1		
May 7	Point Breeze, Penn.	United Gas Improvement Co.					0	2		
May 8	Saratoga Springs, N. Y.	Alva Seybolt's Apartment House	6:30 a.m.	Cast-iron heating			0	0		Not known
May 8	Oil City, Ky.	Price & Kinslow Sawmill		Locomotive type	120	25 hp.	0	3	$300	High pressure
May 9	Fort Wayne, Ind.	Traction plant	2:00 a.m.	Water heater	175		1	1	$1500	Release valve inoperative
May 10	New Orleans, La.	French Market Ice Co.		Water-tube	100		0	1	60	
May 10	Winder, Ga.	Chas. R. Haskin's Ice Plant	7:30	Tubular	100	60″x13′	0	0	$75	Flues thin, failed
May 10	Lebanon, Ky.	Thomas Mattlingly's mill					0	1		
*May 10	Alabama City, Ala.	Standard Steel Co.		Water-tube	150	375 hp.	0	0	none	
*May 11	Alabama City, Ala.	Standard Steel Co.		Water-tube	150	375 hp.	0	0	none	(One also day before)
May 14	Humble, Tex.	Cash Oil Co. Pumping Plant					1	0		
May 14	Omaha, Neb.	Orkin's Store	9:00 a.m.	Water-tube		150 b.hp.	1	1	$100	Tube failure
May 14	Sandusky, Ohio	Sandusky Gas & Elec. Co.		Water-tube			0	0		
May 15	New Orleans, La.	Empire Rice Milling		Horizontal-tubular	100		0	1	$350	
May 15	Toronto, Ont., Can.	Restaurant					0	2		
May 15	Boston, Mass.	Boston Protective Co., Purchase St.		Hot-water heating			0	0		
May 17	Paducah, Ky.	West Kentucky Coal Co.	3:00 a.m.	Firebox	125	48″ shell	2	1	$5000	Low water
*May 19	Flint, Mich.	General Motors Co.	9:00 p.m.	Water-tube vertical	120	5′x24′ 4″	0	0	$45	
*May 19	Bordentown, N. J.	Public Service Corporation		Water-tube			0	0		
May 19	Lumbertown, N. J.	Blacksmith Shop					0	3		
May 19	Union Bridge, Md.	Republic Finance Co.		Water-tube			0	1		
May 20	Kentwood, Ga.	Brooks-Scanlon Co. Planing Mill					0	0		
*May 20	Philadelphia, Penn.	Philadelphia Rapid Transit Co.		Water-tube			0	0		
May 22	Roanoke, La.	Zwick Plantation	6:00 a.m.	Tubular	60-80	100 b.hp.	0	0	$1000	Valve stopped and attendant asleep
*May 24	Waukegan, Ill.	Am. Steel & Wire Co.		Water-tube			0	0		
May 24	Rockland, Me.	W. H. Glover Co.	10:00 a.m.	Horizontal	70	65 hp.	0	0	Boiler only	
May 26	Knoxville, Tenn.	J. A. Smith		Water-tube	100		0	0	$120	
May 26	Pittsburgh, Pa.	H. J. Heinz Co.		Water-tube	125		0	0	$250	
*May 29	Minneapolis, Minn.	Minneapolis Malt & Grain Co.		Water-tube Lyons	150	78″x18′	0	0	$10.50	Oil
May 31	Lima, Ohio	Ohio Electric Railway Co.		Water-tube			0	0		

*Tube failure. †Blowoff failure.

BOILER EXPLOSIONS DURING 1913—Continued

Date	Place	Plant	Time of Day	Kind of Boiler	Pressure Carried, Lb.	Size	Killed	Injured	Property Loss	Probable Cause
June 1	Jennings, La.	E. Houssiere Farm					1	1		
June 3	Long Island City, L. I., N. Y.	Brooklyn Range & Boiler Co.					0	1		
June 3	Leonard, Tex.	Leonard Ice & Coal Co.					0	0		
*June 6	Berlin, Conn.	Berlin Brick Co.					0	0		
*June 6	Burlington, N. C.	Elmira Cotton Mills Co.		Water-tube			0	0		
*June 6	Trenton, N. J.	Public Service Corp.	4:00 p.m.	Water-tube	150	300 b.hp.	0	1	0	Unknown
†June 7	Lancaster, Tex.	Lancaster Milling Co.					0	0		
June 7	Akron, Ohio	Thos. Phillips Co., Paper Mill	9:00 a.m.	Vertical tubular	85	5′x12′	0	1	small	Defective flue; boiler old and in bad condition
June 9	Dunmore, Penn.	Erie R.R. Shops	10:45 a.m.	Water-tube		150 b.hp.	1	2		Cap burst by tigntening under pressure
*June 10	Nadine Sta., Pittsburgh, Penn.	Penn. Water Co., Wildwood	10:00 p.m.	Water-tube			0	1	trifling	
*June 10	Bogalusa, La.	Great Southern Lumber Co.		Water-tube			0	0		
June 12	Manhattan, Kans.	Manhattan Ice, Light & Power Co.	2:00 a.m.	Return tubular	120	150 hp.	0	0		Bag in firesheet. No escape of steam
June 13	Glenn Wilton, Va.	Princess Furnace Co.		Water-tube			0	0		
June 14	Logansport, Ind.	Northern Hospital for the Insane	3:00 p.m.	Water-tube	80	264 b.hp.	0	0	0	Tube stopped causing header to crack
June 16	Stevens Creek, Ga.	J. G. White Construction Co.		Locomotive			0	0		
June 16	Philadelphia, Penn.	Miller Lock Co.		Water-tube			0	0		
*June 16	Kalamazoo, Mich.	King Paper Co.		Water-tube	150	300 b.hp.	1	0	0	
*June 16	Mackinac Island, Mich.	Municipal Water, & Light Co.		Mt. Vernon	150	60″x18′	0	0	$15	
June 16	Akron, N. Y.	Frank Owen	10:00 a,m,	Locomotive type		12 b.hp.	0	0	0	Rusting off of staybolts above crown sheet
June 19	New York, N. Y.	Beth Israel Hospital	4:00 a.m.	Water-tube		80 b.hp.	0	2	$25	Defective tube
June 20	Burlington, Iowa	Burlington Sanitary Milk Co.	6:00 p.m.	Horizontal tubular	100	44″x14′	0	0	repairing	Coming down of scale caused bag
*June 20	Youngstown, Ohio	Brier Hill Steel Co.		Water-tube			0	0		
*June 20	Alabama City, Ala.	Standard Steel Co.					0	0		
*June 20	Louisville, Ky.	Rugby Distillery Co.	10:00 a.m.	Water-tube	125	300 b.hp.	0	3	$500	Unknown
June 20	Somersworth, N. H.	Great Falls Mfg. Co. Cotton Mill					0	0		
*June 21	Jonesville, Mich.	Omega Portland Cement Co.	10:00 a.m.	Water-tube	150	250 hp.	0	0	$300	
June 22	Kalamazoo, Mich.	Paper Mills					1	0		
June 23	Nyack, N. Y.	Lyons Dye Works					0	1		
June 23	Pittsburgh, Penn.	Union Ice Co. Factory No. 2		Water-tube			0	0		
June 24	Louisville, Ky.	Good Luck Polish Co.	5:00 p.m.	Upright	40	3 b.hp.	0	0	boiler only	
June 26	Little Rock, Ark.	Bolz-McBride Cooperage Co.		Horizontal-tubular	100		0	0	$600	
*June 28	Newark, N. J.	Public Service Corporation		Water-tube			0	0		
June 29	Brush, Calif.	Chris. N. Elling Ice & Brick Plant		Tubular	100	40 hp.	0	0	0	Erupted, no explosion
June 30	Chicago, Ill.	C. L. Willey, Lumber Mill		Water-tube			0	0		
*July 2	Brakenridge, Penn.	Allegheny Steel Co.		Water-tube			0	0		
July 2	Conasanga, Tenn.	Alacuky Lumber Co.					0	0		
July 2	Alexandre Bay, Newfoundland	Alexandre Bay Lumbering Co.					5	1		
July 6	Montezuma, Ind.	Marion Brick Works					0	0		
July 7	East Brambleton, Va.	Millner's Dairy					0	1		
July 7	Portage, Penn.	Sonman Shaft					0	0	small	
July 7	Belleville, Ill.	St. Clair County Gas & Elec. Co.					0	1		
July 8	Rockport, Ill.	National Lock Co.	6:00 a.m.	Water-tube	40	250 hp.	0	0	$600	Low water
July 8	Alva, Okla.	Fisher Farm	8:00 a.m.	Return tubular		44″x8′	1	1	$2000	Ignorance, weak material, old age, high pressure
July 10	Brewton, Ala.	T. R. Mills Co.		Locomotive	120		0	0	$400	
*July 10	New Orleans, La.	Central Ice & Cold Storage Co.		Water-tube			0	0	small	
July 11	Norborne, Mo., Carroll Co.	Evan's Farm					1	0		
†July 11	Charlton City, Mass.	Aldrich Mfg. Co., Satinet Mill.		Horizontal-tubular	125	72″	1	0	$500	Careless fitting
*July 11	Minneapolis, Minn.	Minneapolis Malt & Grain Co.		Water-tube			0	0		
*July 12	Alabama City, Ala.	Standard Steel Co.		Water-tube			0	0		
July 13	Pittsburgh, Penn.	Union Ice Co., Factory No. 2		Water-tube			0	0		
July 13	Maricopa, Calif.	National Pacific Oil Co.					0	1		
July 14	Rockford, Ill.	W. F. & John Barnes Co.					0	0		
July 15	Petaluma, Calif.	City Road Work					0	1		
July 15	Superior, Neb.	John Radke Threshing Outfit					0	0		
July 16	Indianapolis, Ind.	Polar Ice. Co.	10:00 a.m.	Tubular	80	66″x16′	0	0	0	Unknown, bagged
July 16	Sandusky, Ohio	Sandusky Gas & Elec. Co.		Water-tube			0	0		
July 17	Clinton, Iowa	Swift & Co.	p.m.	Return-tubular	90	60″x16′	0	0	$4500	Dirty boilers
July 17	Rockdale, Tex.	Vogel Lignite Mine					0	3		
July 18	Trinity, Ala.	Grist and Saw Mill					2	3		
*July 18	Wichita, Kans.	Jacob Dold Packing Co.		Water-tube			0	0		
July 19	Decatur, Ala.	Grist and Saw Mill					2	3		
July 19	Harrison, Ohio	Joseph Kraus Farm	p.m.	Threshing machine	140		0	2	small	Weak place in front of boiler
†July 20	Cleveland, Ohio	Lake City Ice Co.					0	0		
July 21	Trenton, N. J.	Trenton Street Railway Co.		Water-tube			0	0		
July 21	Kalamazoo, Mich.	King Paper Co.					1	0		
July 22	Aguilar, Colo.	National Fuel Co.					0	0		
July 22	Bedford, Ky.	R. L. Conn Traction Engine	7:00 a.m.	Threshing machine	125	16 hp.	0	2	$600	Thin sheet
*July 23	Scranton, Penn.	Am. Gas & Electric Co.		Water-tube			0	0		
*July 24	Blue Island, Ill.	Public Service Corp.		Water-tube			0	0		
July 25	Waukegon, Ill.	Fould's Mill					0	1		
July 25	Windy Point, Del.	Sawmill					1	0		
July 25	Latrobe, Penn.	Railway Steel Spring Co.		Water-tube			0	0		
*July 25	Oxnard, Calif.	American Beet Sugar Co.		Water-tube			1	1	small	
July 25	Camden, N. J.	McAndrews & Forbes Co. Factory		Water-tube			0	0		
July 25	Montreal, Que., Can.	Canadian Car & Foundries Co.	a.m.	Water-tube		350 b.hp.	3	0		
July 30	Columbus, Ohio	U. S. Cast-Iron Pipe & Foundry Co.					0	0		
July 30	Dixon, Ill.	Y. M. C. A. Building		Water-heating			0	0		
July 31	Cypress, Ala.	Southern Cooperage Company		Horizontal-tubular	90		0	0	$300	

*Tube failure. †Blowoff failure.

BOILER EXPLOSIONS DURING 1913—Continued

Date	Place	Plant	Time of Day	Kind of Boiler	Pressure Carried, Lb.	Size	Killed	Injured	Property Loss	Probable Cause
*July 31	Hamilton, Ohio	Hamilton Otto Coke Co.		Water-tube			0	0		
July 31	Tiffin, Ohio	Sun Oil Co.					0	1		
July 31	Grand Mound, Wash.	Briscoe & Co. Logging Camp	2:00 p.m.	Vertical tubular	80		1	0	none	Unknown
*Aug. 1	East St. Louis, Ill.	Swift & Co.		Water-tube			0	2		
*Aug. 2	Helena, Ark.	Helena Gas & Electric Co.		Water-tube			0	0		
Aug. 2	Mason City, Iowa	Farm	2:00 p.m.	Traction engine	120	16 hp.	1	1		Deterioration
Aug. 5	Iowa City, Iowa	Threshing Machine					0	2		
Aug. 6	Philadelphia, Pa.	H. Vaughan		Vertical-tubular	90		0	0	$700	
†Aug. 6	Chaska, Minn.	C. H. Klein Brick Co.	11:30 a.m.		95	66″x16′	0	1		
Aug. 6	New York, N. Y.	Department Store, J. McCreery Co.					1	2		Cast-iron tee ruptured (steam pipe)
*Aug. 6	Sayville, N. Y.	C. M. Rogers					0	0		
Aug. 7	Aberdeen, Wash.	Holi Camp. Willapa Logging Co.					2	0		
Aug. 7	Joliet, Ill.	Public Service Co. of Northern Ill.		Water-tube			0	0		Mud drum exploded
Aug. 9	Clarksville, Tex.	Major's Sawmill	10:00 a.m.	Portable	40 hp.		7	0	$1000	Low water
Aug. 9	Laurel, Miss.	Toy Plant					0	0		
Aug. 9	Pittsburgh, Penn.	Steam Fire Engine					0	3		Steam gage exploded
Aug. 11	Danville, Ill.	David Price's Cannery					1	1		
Aug. 11	Chicago, Ill.	North American Bldg.	3:00 p.m.	Water-tube		250 b.hp.	1	1	nominal	Oil or other foreign matter on surface of tube
Aug. 12	Kansas City, Kan.	Kansas City Packing Box Co.					0	0		Automatic check on steam line ruptured
Aug. 12	Toledo, Ohio	Citizens Ice Co.					1	0		
*Aug. 13	Syracuse, N. Y.	Halcomb Plant (Crucible Steel Co.)		Water-tube	125		0	1		
Aug. 14	New Philadelphia, Ohio	James Wenger's Farm					1	1		
*Aug. 14	Philadelphia, Penn.	Philadelphia Rapid Transit Co.		Water-tube			0	0		
Aug. 14	Keene, N. H.	Beaver Mills					0	0		Stop valve ruptured
†Aug. 15	Hope Valley, R. I.	Locustville Woolen Co.	1:30 p.m.	Return tubular	85	60 hp.	0	1	$25	
*Aug. 16	Brithwaite, La.	Louisiana Pulp & Paper Co.	2:30 p.m.	Water-tube	125	250 hp.	1	0	$600	Forcing fires and poor circulation
*Aug. 16	Clowry, Mich.	Am. Boston Mining Co.		Water tube			0	0		
Aug. 16	Excelsior Springs, Mo.	Excelsior Springs Ice & Storage Co.					0	0		
*Aug. 16	Chicago, Ill.	Gottfried Brewing Co.		Water-tube			1	0		
*Aug. 18	Chicago, Ill.	Grand Pacific Hotel		Water-tube			0	0		
Aug. 19	Union, Miss.	Buntyn Sawmill					4	8		
Aug. 19	Brook, Ind.	Farm	4:30 p.m.	Locomotive type	120		1	0	$300	Carelessness
*Aug. 19	Dobbs Ferry, N. Y.	Manila Anchor Brewing Co.		Water tube			0	0		
Aug. 20	Pittsburgh, Penn.	Rankin Wire Works, U. S. Steel Co.					0	0		Cast-iron mud drum ruptured
*Aug. 21	Ashland, Ky.	Ashland Iron & Mining Co.		Water-tube			0	0		
Aug. 21	Cincinnati, Ohio	Robt. Mitchell Furniture Co.					0	1		Blowoff ruptured
Aug. 22	Rocky Point, Ore.	South Side Timber Co.		Donkey engine			0	1	nominal	Defective safety valve
Aug. 24	Providence, R. I.	Leggett's Drug Store		Hot water			0	5		
Aug. 25	Owasa, Iowa	Steinfeldt Farm	8:30 a.m.	Traction engine			0	2		Defective safety valve
*Aug. 28	New Castle, Penn.	Carnegie Steel Co.		Water-tube			0	0		
Aug. 29	Pittsburg, Kans.	Nevins Coal Co. (No. 6 Mine)					0	0		
Aug. 30	Detroit, Mich.	Murphy Power Co.					0	0		
Aug. 30	Pittsburgh, Penn.	Tug "Alice"					9	6		
Aug. 30	Itasca, Tex.	Itasca Oil Mill	11:30 a.m.				4	0	$15,000	
Sept. 1	Sharpstown, Md.	H. G. Elzey & Sons		Vertical			1	4		Flue collapsed
Sept. 1	Roseau, Minn.	Norquiest Bros. Threshing Outfit	6:00 p.m.	Threshing machine	115	20 b.hp.	1	3	$400	Safety valve stuck
Sept. 2	Ft. Wayne, Ind.	J. A. Moran Ice Co.					0	1		Tube failed
Sept. 2	New York, N. Y.	Schwartzchild & Sulsberger Co.					0	0		Two tubes and cast-iron header failed
Sept. 2	Millington, Md.	Canning Factory	7:30 p.m.	Upright		30 b.hp.	0	2	$75	Low water
*Sept. 4	Dunkirk, N. Y.	Brooks Wks. Am. Locomotive Co.					0	0		
†Sept. 5	Pelham, Ga.	Pelham Mfg. Co.					0	1		
*Sept. 6	Alabama City, Ala.	Standard Steel Co.		Water-tube	150	375 lb.	0	0	0	
Sept. 6	Cheyenne, N. D.	D. O. Ostby Farm	p.m.	Threshing machine			2	1		Failure of water column to show low water
†Sept. 7	Chicago, Ill.	People's Gas Light & Coke Co.					1	0		
Sept. 8	Davenport, Iowa	Linwood Quarries					1	0		
Sept. 9	East Steelton, Penn.	Semet-Solvay Co.		Water-tube			0	0		Cast-iron header failed
Sept. 9	Atlanta, Ga.	Southern Ry. Shops					0	2		
Sept. 9	Ecorse, Mich.	Worcester Salt Co.					0	0		
Sept. 9	Vermillion, S. D.	William Hope Farm	8:00 a.m.	Portable boiler		14 b.hp.	0	4	$25	Too much pressure for an old boiler
*Sept. 10	Ft. Worth, Tex.	Southern Cold Storage Co.		Water-tube	125		0	1		
Sept. 10	Toledo, Ohio	Reliable Laundry & Cleaning Co.					0	0		
*Sept. 10	Philadelphia, Penn.	Philadelphia Rapid Transit Co.					0	0		
Sept. 10	El Reno, Okla.	Trulock Ice Co.		Tubular	100	72″x16′	0	0	0	Fire sheet bagged
Sept. 10	Chicago Heights, Ill.	Chicago Heights Oil Mfg. Co.					0	0		
Sept. 10	Savannah, Ga.	Torpedo Boat Destroyer "Craven"	12:45 p.m.	Normand	240	2776 h.s.	4	2		Low water
†Sept. 11	Mexia, Tex.	Munger Oil & Cotton Co.					0	0		
Sept. 12	Oshawa, Ont.	Seymour Gas Co.	9:30 a.m.	Return tubular		42″x11½′	2	0	$20,000	Low water
Sept. 12	Stage, Miss.	J. S. Rushing Sawmill		Tubular	300	45 b.hp.	2	4	Small $200	Low water
Sept. 13	East Schodack, N. Y.	Merton Garrison					0	0		
Sept. 13	Dallas, Tex.	Dallas Coffin Co.					0	0		
Sept. 14	Waukegan, Ill.	Northshore Gas Co.		Water-tube			0	0		Headers ruptured
Sept. 15	Rahway, N. J.	Waclark Wire Co.					3	0		Steam receiver exploded
Sept. 15	Mt. Airy, N. J.	Mrs. Samuel Dayton		Hot water			0	0	$2000	
Sept. 15	Carleton, Mich.	Williams Bros. Canning Plant	3:30 p.m.	Horizontal tubular	100	150 b.hp.	0	2	Slight	(Mud drum connection failure)
Sept. 16	Bryant, S. D.	Munson Farm		Threshing machine			1	1		
*Sept. 17	New Haven, Conn.	Winchester Rep. Arms Co.					0	2		
Sept. 19	Clinton, N. Y.	Clinton Knitting Co.	1:00 a.m.	Horizontal tubular	75	45 b.hp.	0	0	$2000	Low water and heavily scaled fire sheet
*Sept. 20	Greenport, L. I.	Ulmer Ice Co.	7:00 p.m.	Water-tube	75	16′x6′ 3″	0	1	$15	Deteriorated

*Tube failure. †Blowoff failure.

BOILER EXPLOSIONS DURING 1913—Continued

Date	Place	Plant	Time of Day	Kind of Boiler	Pressure Carried, Lb.	Size	Killed	Injured	Property Loss	Probable Cause
*Sept. 21	Ft. Wayne, Ind.	Ft. Wayne & Northern Ind.		Water-tube			0	0		
Sept. 21	Ecorse, Mich.	Worcester Salt Co.		Scotch marine			0	0		Furnace ruptured
Sept. 23	Ogden, Utah	Banner Canning Co.					0	0		
Sept. 23	Collingwood, Ont., Can.	Blackstock Bros. Dairy Farm	3:00 p.m.	Portable threshing		14 b.hp.	1	3	$200	Unknown
Sept. 25	Garrison, Ky.	Robert Carver's Mill		Locomotive type	110	16 hp.	0	1	$225	Thin place in boiler
Sept. 25	Anniston, Ala.	La Grande Lime Stone Co.					0	1		Blowoff failed
Sept. 26	Troy, N. Y.	Tug "William P. Dalton"					1	0		
Sept. 26	Albia, Iowa	Coal Mine					1	1		
Sept. 26	Terre Haute, Ind.	Terre Haute, I. & E. Traction Co.		Water-tube			0	0		Cast-iron mud drum ruptured
Sept. 26	Arkadelphia, Ark.	W. A. Jones Sawmill					0	4		
Sept. 26	Ecorse, Mich.	Worcester Salt Co.		Scotch marine			0	0		Furnace collapsed
Sept. 27	Bridgeton, N. J.	Clarks Sand Washing Plant					0	0		
Sept. 27	Bridgeport, Penn.	Dechant Construction Co.	1:00 p.m.	Vertical fire tube	75	25 b.hp.	0	3	0	Oily water for feed to boiler
Sept. 28	Hurdsfield, N. D.	Threshing Machine					0	0		
Sept. 28	Taft, Calif.	Tight Wad Oil Co.	12:00 .m				0	1		
Sept. 29	Chaseley, N. D.	Albert Stein	5:00 p.m.	Locomotive type	100	25 hp.	0	4	$1500	Old boiler
Sept. 30	Toledo, Ohio	Toledo Brick & Tile Co.	5:00 p.m.	Return tubular	110	80 hp.	0	0	$200 approx.	Scale over fire, shell ruptured
Sept. 30	La Fayette, Ind.	Opera House		Cast-iron sectional			0	0		
Sept. 30	Brier Hill	Brier Hill Steel Co.		Water-tube			0	0		Three tubes ruptured
Sept. 30	Wilkinsburg, Penn.	Wilkinsburg Bank					0	1		
Oct. 1	Newark, N. J.	Public Service Corporation		Water-tube			0	2		Tube ruptured
*Oct. 3	Milwaukee, Wis.	Plankington Plant Swift Co.		Water-tube			0	0		
Oct. 3	Baltimore, Md.	Guth Chocolate Co.		Internally fired			0	0		Furnace collapsed
Oct. 3	Virginia, Minn.	Steam shovel					0	0		
*Oct. 3	Abbeville, S. C.	Abbeville Cotton Mills		Water-tube			0	0		
*Oct. 5	Cincinnati, Ohio	Merchants Ice & Storage Co.		Water-tube			0	0		
Oct. 5	Albany, N. Y. .	Piano Factory					0	0		
*Oct. 6	Alabama City, Ala.	Standard Steel Co.		Water-tube	150	375 hp.	0	0	0	
Oct. 7	Wheeling, W. Va.	Wheeling Traction Co.	5:30 a.m.	Water-tube		125 b.hp.	0	0	$100	Acid in feed water caused a tube blowout
Oct. 7	Springfield, Minn.	Adolph Trebisch Farm		Threshing machine			0	6		
Oct. 8	Pittsburgh, Penn.	Union Ice Co. 2 Plant		Water-tube			0	0		Cast-iron header ruptured
†Oct. 9	Waelder, Tex.	D. M. Flower's Cotton Gin	3:00 p.m.		120	125 hp.	1	0	0	
Oct. 10	Sewanee, Tenn.	J. W. Light Sawmill	10:00 a.m.	Russell portable	80	25 hp.	2	0	$300	Safety valve overset or stuck
Oct. 10	Niagara Falls, N. Y.	Hooker Electro-Chemical Co.		Water-tube	115	200 hp.	0	0	Repairs	Cast-iron header ruptured
Oct. 10	Redwood Falls, Minn.	Farm					0	6		
Oct. 10	Miley, S. C.	H. W. Lightsey Sawmill	11:00 a.m.	Horizontal tubular	80	60"x16'	1	1		Valve between boiler and safety valve closed
*Oct. 11	Pittsburgh, Penn.	Estate of Jos. W. Arrott		Water-tube			0	0		
Oct. 12	New York, N. Y.	Apartment House 162nd St.		Cast-iron sectional			0	0		
Oct. 14	Boston, Mass.	Apartment House, No. 6 Follen St.		Cast-iron sectional			0	0		
†Oct. 15	So. Acton, Mass.	South Acton Woolen Co.	noon	Return tubular	100		0	0	$300	
Oct. 15	Schenectady, N. Y.	613 State Street	10:00 a.m.	Horizontal	11	4 type	0	1	$1200	Unknown
Oct. 16	Denver, Colo.	Colorado Packing & Provision Co.					0	1		Blowoff ruptured
Oct. 18	Chicago, Ill.	Steel Wedels Co., 151 S. Water St.		Cast-iron heating			0	0		
Oct. 20	Norridgewock, Me.	Harris Danforth	12:30 p.m.	Locomotive type	120	15 hp.	1	0		Crownsheet stay rods failed
Oct. 20	Ranier Beach, Wash.	F. N. Richards Residence					0	0		
Oct. 20	Philadelphia, Penn.	Philadelphia Rapid Transit Co.		Water-tube			0	0		Flue failed
Oct. 20	Louisville, Ky.	Washington School		Cast-iron sectional			0	0		Cracked
Oct. 21	Lynn, Mass.	Troy Laundry					0	0		
Oct. 21	Livingston, S. I.	Richmond Light & Ry. Co.	4:45 p.m.	Vertical water-tube	150	About 300 hp.	7	3	$12,500	Failure of bottom head
Oct. 21	Midland, Ont., Can.	Manley Chew Sawmill	8:00 a.m.				2	3	$8000	
Oct. 21	Youngstown, Ohio	Consolidated Gas & Elec. Co.		Steam receiver			0	3	Small	Receiver head failed
Oct. 21	Scappoose, Ore.	South Side Timber Co.		Logging engine			0	1		
Oct. 23	New York, N. Y.	Apartment House 263 W. 153rd St.		Cast-iron sectional			0	0		
Oct. 23	Eusley, Ala.	Semet Solvay Co.		Water-tube			0	0		Cast-iron headers failed
*Oct. 23	Fremont, Neb.	Electrical and Water Works City		Water-tube			0	0		
Oct. 23	Brooklyn, N. Y.	Ridgewood Pumping Station		Water-tube		250 b.hp.	1	2	None	Defective tube
Oct. 24	Davenport, Iowa	Linde Shoeshop					0	0		
Oct. 25	Meyerstown, Penn.	J. B. Milland & Sons					0	0		
†Oct. 27	Brooklyn, N. Y.	Borden Condensed Milk Co.					0	4		
Oct. 28	Detroit, Mich.	Packard Motor Co.					0	1		
Oct. 31	Bowling Green, Ohio	Pure Ice Co.	10:00 a.m.	Locomotive type	12	12 b.hp.	1	0	$50	Failure of crownsheet staybolts
Oct. 31	Harrisburg, Tex.	C. L. Smith Oil Co.	5:00 a.m.				0	1		
Oct. 31	Oil City, Penn.	McCandless Drilling Co.	10:00 a.m.	Locomotive type		25 b.hp.	1	0	$500	Low water
Oct. 31	Proviso, Ill.	William Ginger Mushroom Plant	8 a.m.	Cast-iron hot water		5 b.hp.	1	0		Ignorance or carelessness of attendent
Nov.	Munfordville, Ky.	J. M. Moss' Sawmill	8:00 a.m.	Locomotive type	125	12 hp.	0	0	$100	Low water
Nov. 4	Frazee, Minn.	Peter Schram Farm					1	2		
Nov. 4	Bryan, Tex.	Artesian Well	5:30 p.m.	Locomotive type	100	50 hp.	0	0	(Boiler only)	Old age, misuse and neglect
Nov. 4	Fond du Lac, Wis.	Y. M. C. A. Bldg.					0	0		
Nov. 10	Franklin, Ohio	Harding Paper Co. Rag Mill	5:20 p.m.				0	1	$30,000	
Nov. 11	Indiana Harbor, Ind.	Inland Steel Co.					3	0		
Nov. 11	Buffalo, N. Y.	Hoeffler Ice Cream Co.					0	1		
Nov. 11	Russell, Ark.	Henry Roetzel Sawmill	6:00 a.m.			60 b.hp.	4	0	$1200	Turning cold water into overheated boiler
Nov. 22	Iona Island, N. Y.	Navy Arsenal					2	0		
Nov. 22	Louisville, Ky.	Seelbach Hotel					0	3		
Nov 22	Tulsa, Okla.	Public Service Corporation	a.m.				0	0		
Nov. 25	Portland, Iowa	Eugene Crowell Farm	9:00 a.m.				0	1		Old boiler
Nov. 26	Calumet, Mich.	Finnish Lutheran Book Concern	a.m.				0	0		Low water
Nov. 27	Philadelphia, Penn.	Bergdoll Brewing Co.	p.m.				0	1		

*Tube failure. †Blowoff failure.

BOILER EXPLOSIONS DURING 1913—Continued

Date	Place	Plant	Time of Day	Kind of Boiler	Pressure Carried, Lb.	Size	Killed	Injured	Property Loss	Probable Cause
Nov. 27	Rue, Ala.	Price Sawmill	a.m.	Tubular	100	50 b.hp.	3	2	$200	Pumping water into empty boiler
Nov. 30	Calais, Me.	St. Croix Opera Block		Hot water		38" fireproof	0	0	$50	Too hot fire made steam
Dec.	Mason City, Iowa						0	1		
Dec.	Chicago, Ill.	Chicago Distillery					4	0		
Dec. 1	Brooklyn, N. Y.	Standard Oil Can Factory					1	0		
Dec. 1	Boston, Mass.	Jefferson Bldg.					0	0		
Dec. 4	Pittsburgh, Penn.	Brown & Co.	4:00 p.m.	Upright water tube	120	150 b.hp.	0	0	$1500	Bursted tubes
Dec. 5	Albany, N. Y.	Enterprise Fire Co. Plant					0	0		
Dec. 6	Waco, Tex.	Texas Power & Light Co.					0	3		
Dec. 8	Rocky Ridge, Pa.	Beck & Yo.	10:30 p.m.	Locomotive type	120	25 hp.	0	1	$400	Safety valve stuck
Dec. 9	Derby, Penn.	East Fourth St.					0	0		
Dec. 9	Philadelphia, Penn.	O. D. Wilkinson, 2010 Walnut St.	a.m.	Hot water	0		0	0	1 Section	Boiler full and valves closed when fire was built
Dec. 12	Norwich, Conn.	Shore Line Electric Ry. Co.	5:00 a.m.	Water-tube	155	250 b.hp.	0	2	0	(Tube blowout) due to failure of weld
Dec. 12	Ellisburg, Ky.	Gassberry Sawmill	p.m.				0	1		
Dec. 13	Jersey City, N. J.	Patterson-Alnen Co.					0	0		
Dec. 13	Wilmington, Del.	Boston Clothing Store					0	2		
Dec. 14	Arlington Center, Mass.	Arlington Gas Light Co.					1	11		
Dec. 15	Brookline, Mass.	Apartment House					0	2		
Dec. 15	Lockhart, Ala.	Jackson Lumber Co.					1	1		
Dec. 16	Sistersville, W. Va.	Boiler Works					1	0		
Dec. 16	Nashville, Tenn.	Harcourt Apartments					1	2		
Dec. 16	Lockhard, Ala.	Jackson Lumber Co.					0	0		
Dec. 16	Chicago, Ill.	Harcort Apartment, 1375 E. 57th					1	2		
Dec. 18	W. N. Brighton, N. Y.	Interborough Garage					0	0		
Dec. 19	Brooklyn, N. Y.	Sands St. Memorial M. E. Church					0	0		
Dec. 19	Fritchton, Ind.	Andy Steffy Farm	9:00 a.m.				0	1		
Dec. 19	Highway, Ky.	Smith Bros. Sawmill	4:00 p.m.	Locomotive type	120	30 hp.	1	3	$600	Mud in the boiler
Dec. 20	Fertigs, Penn.	C. P. Irwin	1:00 a.m.	Locomotive type		25 b.hp.	0	0	$300	Valve closed between safety valve and boiler
Dec. 21	Bismarck, Mo.	Banie Iron Co. Sawmill		Drilling outfit			1	2		
Dec. 22	Greenville, Penn.	Greenville Elec. Lt., Ht. & Pr. Co.	p.m.				0	1		
Dec. 24	Richmond, Ind.	Standard Oil Plant					0	1		
Dec. 26	Toledo, Ohio	Mrs. P. Relzeke's House					0	3		
Dec. 28	New Haven, Conn.	97 Chapel St.					0	0		
Dec. 28	Ellicottville, N. Y.	Holy Name Church					0	0		
Dec. 28	Utica, N. Y.	W. A. Semple's Store	12:03 p.m.	Domestic hot water			0	0	0.50	Frozen pipe connection
Dec. 30	Pittsburgh, Penn.	406 Westminster St.					0	0		
Dec. 30	Brookville, Ind.	William Craig Traction Engine	2:00 p.m.	Peerless	105	10 hp.	0	1		Cold water and weakness of boiler

Mechanical Engineers' Spring Meeting

The spring meeting of the American Society of Mechanical Engineers was held, a couple of weeks later than usual, at St. Paul and Minneapolis during the week commencing June 15. The registration was one short of 400 and the meeting from all standpoints a decided success.

At its opening session the Society was welcomed to Minnesota by Governor A. O. Eberhardt and Max Toltz, chairman of the local committee, the response for the Society being made by Vice-President H. L. Gantt in the absence of President Hartness who was at New Haven receiving the honorary degree of Master of Arts from Yale University. Remarks were also made by Paul Doty of the local committee and others.

At the business meeting on Wednesday forenoon the report of the Committee on Pipe Flanges was discussed. "Power" readers are familiar with the attempt of the Mechanical Engineers, the National Association of Master Steam and Hot Water Fitters and other societies to establish a uniformity of practice in this particular, which resulted in the "U. S. 1912 Standard" and the promulgation by dissenting manufacturers of the "Manufacturer's Standard." At a conference on March 20 of this year, these differences were reconciled and a mutually acceptable schedule agreed upon, but a conflict of opinion, and interest has developed regarding the name by which the schedule shall be known. The National Association of Master Steam and Hot Water Fitters, who originated the movement and who have been particularly aggressive in carrying it through, hold that they are entitled to the prestige, which will come with the recognition of the fruition of their efforts by the retention of the designation of the schedule for which they have contended with a simple change of date, and urge that the successful schedule be termed the U. S. (United Societies) standard of 1915. Others contend that the modification of this standard should be emphasized by giving it a distinctive title and wish to call it the "American Standard of 1915". The case of the Master Steam and Hot Water Fitters was ably presented by Messrs. Childs and Denning and it was voted to refer the choice of a name to a committee made up of a representative of each society interested.

The interest of the business session centered in the report of the Committee on Standard Boiler Specifications. This committee was appointed, not as some maintain simply to evolve a blueprint of a standard horizontal tubular boiler, but to report to the Council recommendations bearing upon the situation brought about by the adoption of conflicting laws by various states and municipalities regarding the construction and operation of boilers and other pressure vessels. They have prepared a tentative report suggesting a form of law, which may be universally adopted and rules, following closely those of Massachusetts and Ohio regarding the design and proportions of such vessels and other appliances. Nearly two thousand copies of this tentative report have been sent to specialists for criticism and suggestion and its discussion was looked forward to with much interest. Following a meeting of the Council, an announcement was made that no discussion of the report in detail would be permitted at this meeting, but that its consideration would be limited to remarks upon the broad subject by representatives and the committee. Thomas Durban on behalf of the organized boiler manufacturers and Dr. Jacobus on behalf of The Babcock & Wilcox Co., urged immediate action. Mr. Durban said that his association had presented the situation to the governor and leaders of legislatures in every state that action in many states was imminent, and threatened, if the Society did not take immediate steps to suggest and direct legislation of this sort, that it would be done by his own organization.

Mr. Carhart of the Association of Steel Manufacturers said that his constituents were ready to furnish the boiler manufacturers with material practically and commercially adapted to their requirements, but that the requirements of the committee were excessive and commercially impracticable. In passing it may be said that there had been a conference between representatives of the boiler makers, the steel manufacturers, and the committee on Monday in which the boiler makers and the committee had taken the ground that being purchasers they were the judge of what they wanted and should be furnished with it if they were willing to pay the price.

The steel manufacturers maintain that steel of 0.3 to 0.5 per cent. manganese, 0.3 per cent. phosphorus and 0.03 per cent. sulphur is too difficult to make and unnecessarily good for boiler work, and claim that they must be allowed to sell the boiler makers both firebox and flange steel, as the latter affords an outlet for the rejecta of the former grades.

It was decided that the committee should give a public hearing, to which all parties in interest should be invited, at the United Societies Building in New York on September 15. Those desiring to present criticism, argument and suggestion shall present it in writing not later than August 15. An attempt to include representatives of other societies with voting power was overwhelmingly defeated.

The professional session of Wednesday morning was devoted to the discussion of Pulverized Coal, its use in the cement industry being described in a paper by Dr. R. C. Carpenter, for steam making in a paper by F. R. Low, and its use in industrial furnaces in a paper by W. S. Quigley. Abstracts of these papers and their discussion will appear in later issues.

Other papers of interest to "Power" readers presented at this meeting, and which will receive further attention in our columns are: "Classification and Heating Value of American Coals," by William Kent; "A Flow Metering Appliance," by A. M. Levin; "Power Development at the High Dam between Minneapolis and St. Paul," by Adolph F. Meyer, and "The Handling of Coal at the Head of the Great Lakes," by G. H. Hutchinson.

On Wednesday evening John Hearding, superintendent of the Oliver Iron Mining Co., gave an interesting lecture illustrated by moving pictures upon mining methods and ore handling.

Thursday's session was held at the University of Minnesota at Minneapolis, where addresses of welcome were delivered by President Snyder of the Board of Regents and H. T. Eddy, Dean of the Engineering College.

In the afternoon the society was entertained by Gebhard Bohn at his estate on Lake Minnetonka.

Friday was devoted to visits to industrial establishments, power plants, etc., a large number of members going to Duluth. Under the escort of local members they were given a moonlight excursion about the harbor on Friday evening, and on Saturday another excursion by steamer to the new works of the Minnesota Steel Company now under construction.

Kentucky N. A. S. E. State Convention

From June 3 to 5 the engineers of Kentucky held their 12th annual convention in Louisville. The headquarters of the exhibitors was in Liederkranz Hall, and with the exception of the first meeting the engineers conducted their business in Odd Fellows Hall, the regular meeting place of No. 1. Fully 90 engineers were registered, and 34 companies displayed an unusually good exhibit.

Wednesday was given over to a reception in the parlors of the Hotel Watterson to delegates and visitors, and in the evening Kentucky No. 1 treated the boys to a boat ride on the Ohio River. Music, dancing and refreshments added to the pleasure of the trip.

On Thursday forenoon the convention was opened in the exhibit hall by Charles Fertig, chairman of the local committee. Louis Stein, secretary of the mayor, welcomed the delegates to the city and a witty response was made by State President Carroll. J. H. Saunders, president of the commercial club, spoke of Louisville's growth and business, and urged the engineers to call on the club for anything that lay in its power to give. Robert W. Larkin, general manager of the "National Engineer," responded in his usual forceful style.

R. W. Brown, of the Convention and Publicity League, made a plea for Louisville as the annual convention city. He complimented the state organization on its success. It was a day of coöperation in which men must get together, exchange ideas and help each other in every way possible. F. L. Ray, vice-president of the national body, responded and delivered an eloquent address. He spoke at length on the purposes and plans of the National Association of Stationary Engineers and of the great value of the educational work conducted. No one is more responsible than the engineer for the health and happiness of the people at large, and it should be his earnest endeavor to make himself worthy of the trust. Every engineer should give more time to his own advancement and in this way reflect credit on the national organization. There is a great future for the engineer, and if the members will take advantage of the opportunities offered, the association will soon become the supreme factor in engineering progress.

In behalf of the Central States Exhibitors' Association President Cullen spoke briefly, calling attention to the exhibits and requesting an inspection by the engineers, their superintendents and managers and the public men of the city. The convention was then turned over to State President Carroll. Before adjournment the usual committees were

Delegates and Supply Men at the Kentucky N. A. S. E. State Convention, June 3-5, 1914

appointed and the exhibit was formally opened by Mr. Cullen.

In the afternoon the first business session was held. Reports by the treasurer, secretary and various committees were followed by a short talk on the "Relation of Stationary Engineers to the Boiler Inspector," by L. Z. Brainard, manager of the St. Louis district for the Travelers' Insurance Co. R. B. Larkin spoke on "Our Paper," giving an insight into the cost of producing it and the possibilities of the future, providing it was given the earnest support of the various members of the association.

A smoker tendered the engineers by the exhibitors was the feature of the evening. Charles Cullen was the jovial toastmaster of the affair and was ably assisted by Messrs. Fiske, Wunder, Jones and Stout. Delegates from the various locals were also called to the rostrum to entertain by song or story.

At the second business session on Friday morning, Lexington was chosen as the next convention city. A paper dealing with the dry vacuum pump was read; there was also considerable discussion on the educational work of the associations. Members from the various locals told what their respective lodges had been doing. It was the consensus of opinion that the elementary courses should be given more attention. At least, they should be taken up before attempting the more technical studies on flue-gas analysis and kindred subjects. For the younger men the simple, practical work of the engine room, such as setting valves and keeping records, was recommended.

The following officers were elected: State president, G. J. Jake, Hopkinsville; vice-president, C. F. Moore, Lexington; secretary, August Pohl, Louisville; treasurer, L. N. Lowrey, Hopkinsville; conductor, R. V. Cason, Central City; doorkeeper, W. G. Russell, Henderson. C. Carroll, retiring president, was recommended to the national body as state deputy.

The afternoon was well spent in a visit to the High Street power station of the Louisville Ry. Co., and to the Crescent Hill pumping and filtering station. In the evening the National Tube Co.'s lecture, "From Ore to the Finished Tube," illustrated by motion pictures, was given by W. A. Fhillis, of Pittsburgh. There was a good attendance to hear and appreciate the closing feature of the program.

Following is a list of the active members of the Central States Exhibitors' Association, who were represented and had exhibits: American Steam Gauge & Valve Co., The V. D. Anderson Co., Crandall Packing Co., Dearborn Chemical Co., The Garlock Packing Co., Greene, Tweed & Co., Hawk-Eye Compound Co., Home Rubber Co., Jenkins Bros., H. W. Johns-Manville Co., Keystone Lubricating Co., The Lunkenheimer Co., H. Mueller Co., "National Engineer," The Perolin Co. of America, William Powell Co., "Power," White Star Refining Co.

Associate members exhibiting were Ahrens & Ott Mfg. Co., The James Clark, Jr., Electric Co., Andrew Cowan & Co., Hafer Foundry & Machine Works, Indian Refining Co., The Jenkins Graphite Lubricating Co., Laib Co., Louisville Sanitary Wipers Co., Henry H. Martin Manufacturing Co., Moran Flexible Steam Joint Co., E. D. Morton & Co., W. H. Neill Co., Peerless Rubber Manufacturing Co., United States Graphite Co., Henry Vogt Machine Co., Harry S. Wood Co.

Those contributing but not showing their products were A. J. Anderson Co., Childens & Waters Co., Southern Manufacturers & Supply Co., Standard Oil Co.

Iowa N. A. S. E. State Convention

At Des Moines, on June 3 to 5, the Iowa state convention was a decided success. The attendance was large, the exhibits good and the program excellent. Headquarters were at the Savoy Hotel. The exhibits occupied the entire main floor of the Des Moines Auditorium and the sessions were held in the assembly room of the same building.

At 1:30 Wednesday the first session was called to order by State President John Devine. Mayor Hanna welcomed the engineers to the city, and was followed in a brief address by Hon. G. W. Clarke, governor of Iowa, who highly commended the educational work conducted by the association. Fred W. Raven, national secretary, responded. The convention adjourned to inspect some of the power plants of the city, and in the evening the engineers were entertained at White City, Des Moines' amusement park.

On Thursday morning State Commissioner Warren Garst addressed the convention on the "Workmen's Compensation and Employers' Liability Law," and in the afternoon an interesting lecture on "The Burning of Iowa Coal" was delivered by Prof. W. H. Meeker, of Ames College. He showed how the native coal could be used to advantage by mixing it with Illinois coal, and suggested how some of the objectionable features in its burning could be eliminated. It was Prof. Meeker's opinion that the efficiency problems of the future would be worked out in the boiler room. Intelligent firemen should, therefore, be employed, and their wage should equal that paid engineers.

In the evening an athletic carnival featured by a "battle royal" was followed by an old-fashioned Dutch lunch.

At the business meeting Friday morning agitation was made for a state license law. Des Moines, Sioux City and Waterloo now have local laws and Clinton and Davenport engineers have been carrying on a vigorous campaign to get similar measures passed in their respective cities. A fund accumulated for the purpose will be used to further a campaign for a state license law before the next legislature.

F. H. Faas, of Cedar Rapids, then read a paper on the "Operation and Care of Steam Turbines." At the afternoon session a paper on "Stuffing a Cylinder Head" was read by Lafayette Young, Sr. The last business session followed, in which Clinton was chosen as the next convention city.

The following officers were elected:

J. A. Goddard, president; E. O. Landis, vice-president; Abner Davis, secretary; F. P. Boone, treasurer; A. C. Garrison, conductor; C. C. Ranzan, state deputy.

In the evening a three-reel motion photo showing the

DELEGATES AND GUESTS AT THE IOWA STATE N. A.

manufacture of boiler tubing from the ore to the finished product was greatly appreciated. Following is a list of the exhibitors:

THE EXHIBITORS

Quaker City Rubber Co.
Hawkeye Compound Co.
Carbon Coal Co.
Griscom-Russell Co.
Greene, Tweed & Co.
Valvoline Oil Co.
Western Valve Co.
Anchor Packing Co.
Dearborn Chemical Co.
Murray Iron Works
George B. Carpenter Co.
Western Boiler Compound Co.
Manhattan Oil Co.
National Tube Co.
McGraw Co.
Jenkins Bros.
Mills-McCanna Co.
Crane Co.
Garlock Packing Co.
Mark Manufacturing Co.
H. W. Johns-Manville Co.
Globe Machinery & Supply Co.
Crandall Packing Co.
Iowa Electrical Supply Co.
Keystone Grease Co.
Viscosity Oil Co.
Lunkenheimer Co.
V. D. Anderson Co.
Highland Park College
Iowa Machinery & Supply Co.
Herf & Frericks Chemical Co.
Standard Oil Co.
"National Engineer"
Fisher Governor Co.
National Ammonia Co.

Kansas State Convention N. A. S. E.

On June 3 to 5, Kansas engineers held their second annual convention at Atchison. The official headquarters were at the Byram Hotel, the business sessions were held in the audi-

State Convention Group at Atchison, Kansas

S. E. Convention, Des Moines, June 3 to 5, 1914

torium of the Atchison high school and the exhibit in Turner Hall.

Mayor Finney delivered the address of welcome, and the response was made by L. E. Weaver, state president of the association. Mr. Weaver dwelt at some length on the mutual benefits to be derived from state license laws by both engineers and employers. W. J. Bailey, a former governor of Kansas, talked along efficiency lines and the work of the engineer, Willard Morris, chairman of the local committee, then turned over the meeting to President Weaver, who appointed the usual committees.

At noon the exhibits at Turner Hall were formally opened. In the afternoon the session was devoted to business. Thursday morning Fred W. Raven spoke of the advantages of a state license law and at the afternoon session Hon. Sheffield Ingalls, lieutenant-governor of Kansas, and William Washer addressed the meeting. In the evening N. T. Veach, superintendent of public schools, delivered a lecture, with lantern slides, on the "Panama Canal."

On Friday officers were elected and installed, the conventioners were treated to a sight-seeing tour over the city, and in the evening the convention was brought to a close with a banquet at the Byram Hotel.

"The Managing Engineer"—This is a new English monthly magazine devoted to the welfare of managers and chief engineers throughout the United Kingdom. It will publish all papers read before the engineering associations and invites free discussion of questions of moment to the engineer. The magazine is the official organ of the London Association of Foremen Engineers, and the Leeds Association of Engineers, and is negotiating with other large associations to that end. "Power" congratulates Thomas Tofts, its publisher on its excellent appearance and believes it will find a wide use in its field.

TRADE CATALOGS

Lunkenheimer Co., Cincinnati, Ohio. Booklet. "Renewo" valves. Illustrated, 12 pp., 3½x6 in.

Sprague Electric Co., 527-31 W. 34th St., New York. Pamphlet No. 905. Illustrated, 32 pp., 4x9 in.

Buckeye Engine Co., Salem, Ohio. Bulletin No. 111-B. Buckeye-mobile. Illustrated, 16 pp., 8x10½ in.

The Kelly & Jones Co., Greensburg, Penn. Catalog M. Pipe fittings, valves, etc. Illustrated, 444 pp., 5x7½ in.

Detroit Leather Specialty Co., Inc., Detroit, Mich. Catalog. Wear Well leather packings. Illustrated, 20 pp., 6½x9½ in.

Reeves-Cubberley Engine Co., Trenton, N. J. Catalog No. 17. Reeves steam engines. Illustrated, 36 pp., 8x10½ in.

Bury Compressor Co., Erie, Penn. Catalog No. 44. Air and gas compressors, vacuum pumps. Illustrated, 40 pp., 6x9 in.

The Smith Gas Producer Co., Lexington, Ohio. Catalog No. 9. Gas producers for bituminous coal. Illustrated, 26 pp., 6x9 in.

Brown Hoisting Machinery Co., Cleveland, Ohio. Catalog D. Tramrail systems, trolleys, electric hoists. Illustrated, 64 pp., 6x9 in.

Chicago Pneumatic Tool Co., Fisher Building, Chicago, Ill. Bulletin No. 34-C. Gasoline driven air compressor. Illustrated, 16 pp., 6x9 in.

Wm. B. Scaife & Sons Co., Pittsburgh, Penn. Bulletin. Underground gasoline storage outfits and welded tanks. Illustrated, 12 pp., 6x9 in.

American District Steam Co., North Tonawanda, N. Y. Bulletin No. 133. Atmospheric system of steam heating. Illustrated, 30 pp., 6x9 in.

Enell-Smith Manufacturing Co., Newark, N. J. Catalog. Lippincott indicators, for steam and gas engines, ammonia compressors. Illustrated, 7x9 in.

Edge Moor Iron Co., Edge Moor, Del. Bulletin No. 53. "High Boiler Efficiency with Low Grade Coal." Tests of a four-pass boiler with Illinois coal. Illustrated, 20 pp., 6x9 in.

Link-Belt Co., Chicago, Ill. Advance Section A, General Catalog No. 110. Original Ewart detachable link belt and sprocket wheels. Illustrated, 110 pp., 6x9 in. Book No. 190. Wagon and truck loaders. Illustrated, 32 pp., 6x9 in.

The Bristol Co., Waterbury, Conn. Bulletin No. 188. Recording differential pressure gages and recording flow-rate meters. Illustrated, 12 pp., 8x10½ in. Bulletin No. 189. Recording differential pressure gages and recording flow-rate meters, float type. Illustrated, 8 pp., 8x10½ in.

BUSINESS ITEMS

William Floyd Lee, chief engineer of C. W. Hunt Co., Inc., West New Brighton, N. Y., at a recent meeting of the board of directors, was elected vice president and chief engineer of the company.

The Erie City Iron Works, Erie, Penn., during the week of June 8th booked orders for 17 boilers, 9 engines and 20 tanks: on Monday, June 15, they received orders for two engines and nine boilers.

The Cleveland Electric Illuminating Co., Cleveland, Ohio, recently ordered thirty-one 2½-in. Simplex valves from the Yarnall-Waring Co., making five orders in two years from this company, totaling seventy-two 2½-in. valves.

The Terry Steam Turbine Co., Hartford, Conn., has just finished one of the largest months in the history of its business, in point of orders received. Additional machinery has been installed increasing the capacity of the plant about 25%.

On account of the growing volume of business the Skinner Engine Co., Erie, Penn., has found it necessary to run their works at night. In order to avoid the night work in future, they have contracted for a large extension of their shop buildings and also ordered the necessary new equipment.

E. W. Alderman, an experienced refrigerating engineer, who has been connected with the Vilter Manufacturing Co. for a good many years, has been appointed manager of the Pittsburgh district and will have his headquarters at 314 Curry Building, Pittsburgh, Penn. He succeeds H. W. Loecher, who has been transferred and will be located at the main office here in Milwaukee.

The C. & G. Cooper Co., Mt. Vernon, Ohio, is shipping two compressor units to the Columbia Gas & Electric Co.'s Branchland, W. Va., pumping station, which will deliver about 14,600,000 cu.ft. of free gas per 24 hours against a pressure of 275 lb.—is building a 24x48 twin tandem compressor unit for the Logan Natural Gas & Fuel Co.—and has received orders from the Altoona Portland Cement Co., Altoona, Can., for a 21x30-in. single-tandem Cooper gas engine, and from the Marshall Field Estate for three Corliss engines.

NEW EQUIPMENT

ATLANTIC COAST STATES

The Citizens Light, Heat & Power Co., Johnstown, Penn., contemplates constructing a central-power plant at Seward. P. J. Morrisey, Johnstown, is general manager.

The Bucks County Electric Co., New Hope, Penn., will construct an electric light and power plant. W. H. Janney, Newtown, is manager.

Bids will be received by the borough council, Tarentum, Penn., until July 13, for constructing a reinforced-concrete power house. Leo Hudson, House Bldg., Pittsburgh, is consulting engineer.

SOUTHERN STATES

The Columbus Power Co., Columbus, Ga., will install an additional 5000-kw. unit at the Goatrock station.

The Union Redrying Co., Lexington, Ky., is in the market for boilers for enlarging the capacity of its tobacco plant.

The C. Lee Cook Manufacturing Co., Louisville, Ky., is in the market for the following first-class and second-hand machinery: One 300 hp. or two 200 hp. water-tube boilers capable of 150 lb. steam pressure; two standard two-stage modern high-duty air compressor with 700 ft. free air capacity; one duplex 800-gal. fire pump; one 10 to- 15-kw. direct-connected direct-current engine, generator set, either 110 or 220 volts, the latter preferred; one standard gage saddle-tank locomotive capable of 140 lb. steam pressure with about 12-in. cylinders; one 600 hp. wet vacuum pump, duplex and flywheel type preferred, and one standard gage locomotive crane with approximately a 30-ft. boom and 10-ton capacity.

The Purified Petroleum Products Co., Louisville, Ky., is in the market for a 20-hp. motor, pumps and other equipment for a new plant which it will erect in the immediate future. G. A. Shaw, Louisville Trust Bldg., is in charge.

The Patterson Sand Co., 2615 Crop St., Louisville, Ky., is in the market for a motor-driven hoist, with drum and wire cable.

The Houston Electric Co., Houston, Tex., contemplates spending $2,000,000 for improvements to its plant.

The Louisville Gas & Electric Co., Louisville, Ky., contemplates spending about $400,000 for the construction of an extension to its plant on Washington St.

The Dayton Light & Power Co., Dayton, Tex., which has been recently organized, will construct an electric-light and power plant at Dayton. A. E. Kerr is interested.

The electric-light plant of the Taft Gin & Oil Co., San Antonio, Tex., which was recently destroyed by fire, will be rebuilt.

WEST OF THE MISSISSIPPI

Bids will soon be received for the construction of a municipal electric-light plant at Hills, Minn. Earl D. Jackson, Capitol Bank Bldg., St. Paul, is consulting engineer.

WESTERN STATES

The city of Nehalem, Ore., contemplates constructing a municipal electric-light plant.

The City Electric Co., San Francisco, Calif., will construct a substation a Harrison and Haywards Sts., to cost $15,000, exclusive of equipment. E. W. Beardsley is general superintendent.

The Pacific Gas & Electric Co., San Francisco, Calif., will build a concrete power station at Eighth and Minna Sts. John A. Britton is vice-president and general manager.

CANADA

Bids will be received by the city secretary-treasurer, P. J. Stephens, Estevan, Sask., until July 1, for furnishing and installing two 250-kw., 2300-volt, three-phase, 60-cycle, alternating-current generators, two exciters, one 500-kw. 2000-volt, three-phase, 60-cycle alternating-current generator and the necessary connections. S. G. Dethridge is engineer.

It is reported that the town of Prince Rupert, B. C., will install a municipal power plant to cost about $300,000.